OCTOBER 1956

THE WELDING JOURNAL

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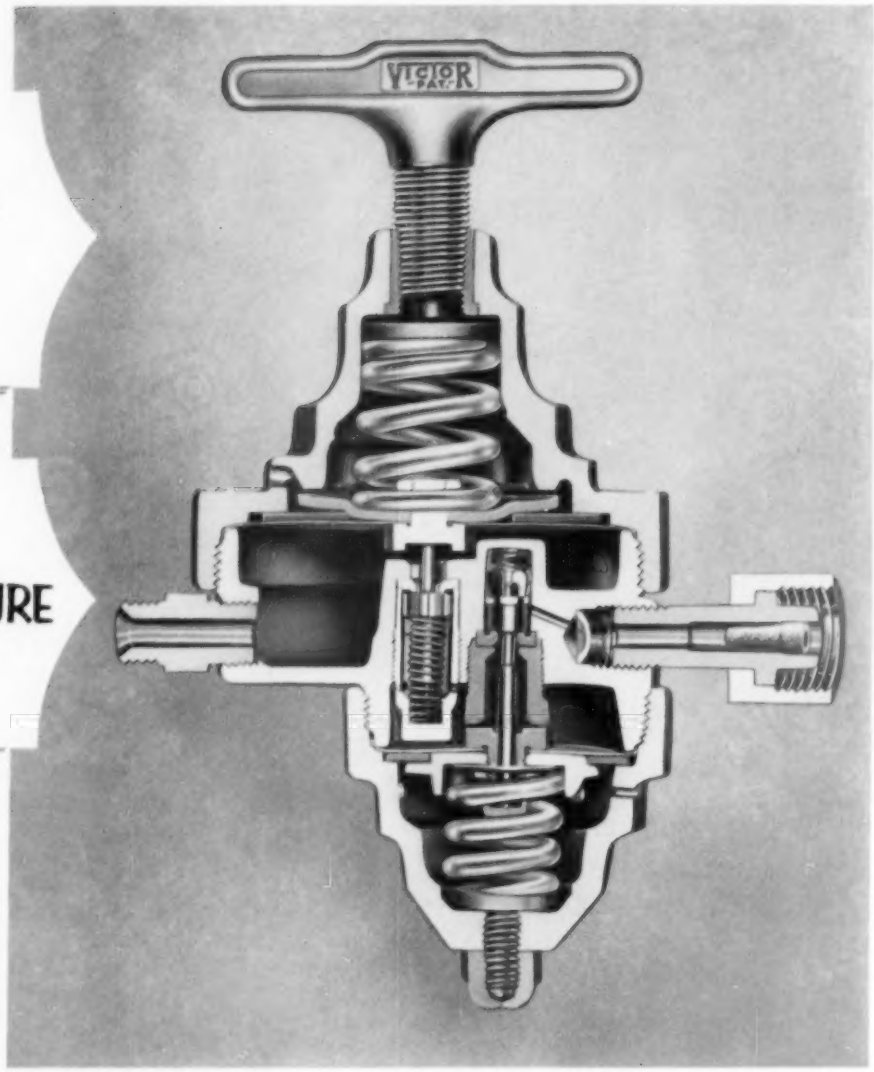

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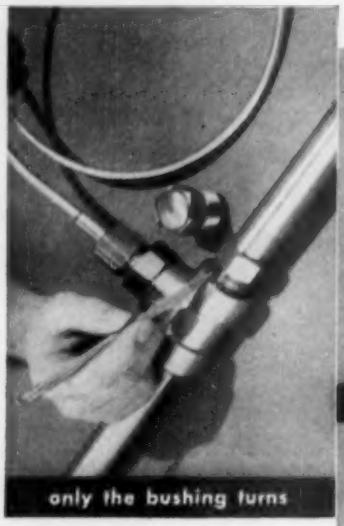

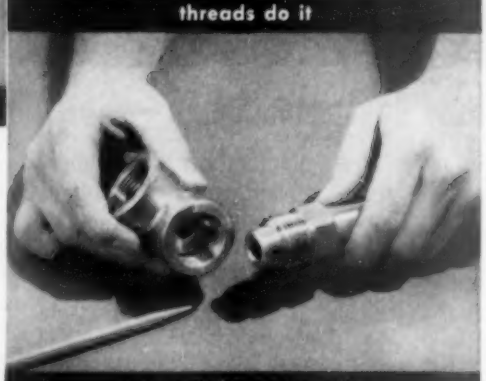

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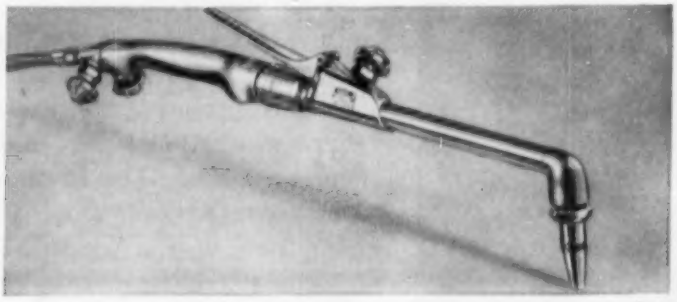

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VOLUME 35 • NUMBER 10 • OCTOBER 1956

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Published for the advancement of the science and art of welding by the American Welding Society

Published monthly by the American Welding Society. Publication office, 20th and Northampton Streets, Easton, Pa. Editorial and general offices, 33 West 39th St., New York 18, N. Y. Subscriptions $7.00 per year in the United States and possessions; foreign countries $8.50. Single copies, nonmembers $1.00; members 75 cents. Entered as second-class matter January 5, 1932, at the Post Office at Easton, Pa., under the act of March 3, 1879.

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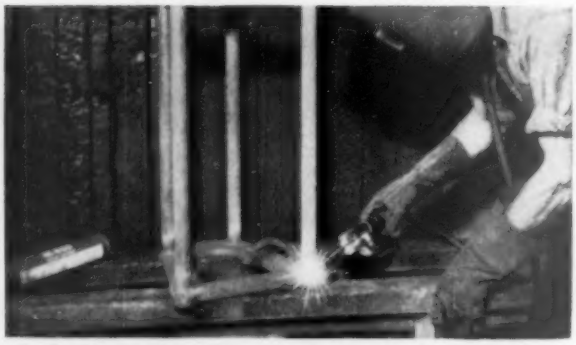

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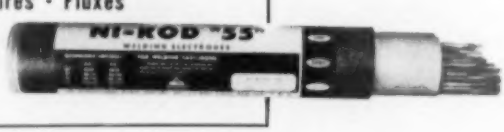

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EDITORIAL

THE INDIVIDUAL AND THE SOCIETY

What can the AMERICAN WELDING SOCIETY mean to a member? To give one answer to that question, my thoughts turn back over the thirty years that have gone by since I received membership card No. 760. The SOCIETY was young in 1926, with a total of only 845 members. The welding industry had hardly crossed the threshold of the almost bewildering developments in the years that have intervened.

The growth of the SOCIETY attests to the soundness of its purpose, but also to an intangible spirit of cooperation that has motivated so many of its members. A willingness to share knowledge and experience through the various channels provided by the SOCIETY has long been one of its distinctive features.

Participation in the activities of the SOCIETY is a key that unlocks the doors to unlimited personal satisfactions for any member. Perhaps the greatest of these, and certainly the most treasured in later years, are the friendships that inevitably grow out of associations with others in working together for a common interest.

For most members, the meetings of their local Section are of the greatest practical interest. From the speakers, from the discussions that follow, and from the exchange of ideas with other members, one may keep abreast of developments in welding and their applications in industry. Serving on one of the committees of the Section, or as an officer, will bring added returns to any member who takes an active part in its affairs.

Many members devote long hours to the work of the standing committees and of the technical committees of the SOCIETY. It is an educational experience to be a member of such a committee and well worth the required effort.

Through the medium of THE WELDING JOURNAL, the SOCIETY offers to its members an authoritative source of information on welding and on the research work into many aspects of welding. The preparation of a paper for THE WELDING JOURNAL, while it involves time and effort, is a rewarding way in which a member may participate in the cooperative work of many to make the SOCIETY a truly worthy organization.

The underlying thought of this editorial is well epitomized in these lines from the poem "Life's Mirror" by May Ainge de Vere:

"Then give to the world the best you have,
And the best will come back to you."

H. Malcolm Priest
HONORARY MEMBER
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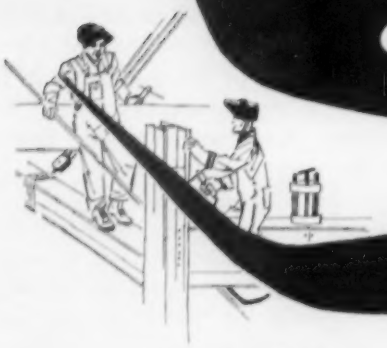

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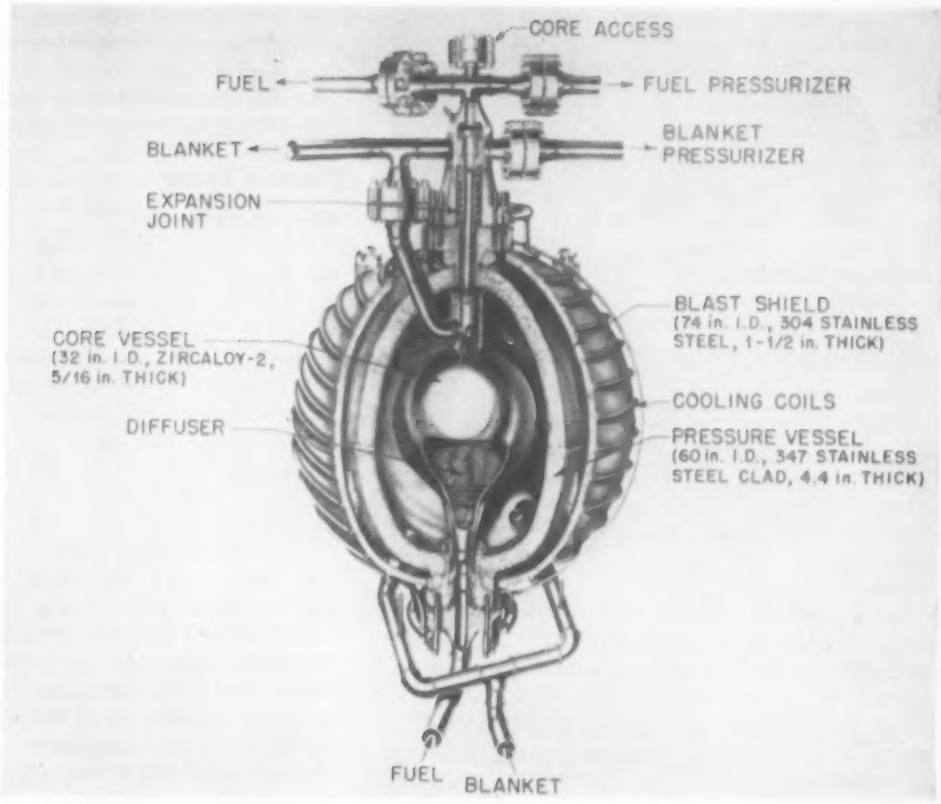

Fig. 1 Homogeneous reactor test vessel assembly

FABRICATION OF THE HOMOGENEOUS REACTOR TEST VESSEL ASSEMBLY

BY L. F. BLEDSOE, F. V. DALY, G. E. ELDER, W. R. GALL AND E. C. MILLER

Special fabrication problems created by unusual requirements of design and application are described and discussed

L. F. Bledsoe and **F. V. Daly** are associated with the Newport News Shipbuilding & Drydock Co., Newport News, Va.; **G. E. Elder** is with Electro-Mechanical Labs., White Sands Proving Ground, N. Mex.; **W. R. Gall** and **E. C. Miller** are associated with Union Carbide Nuclear Co., Oak Ridge, Tenn.

Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7–11.

Introduction

The Homogeneous Reactor Test (HRT) is the second experimental aqueous homogeneous reactor which will be operated by the Oak Ridge National Laboratory of the Union Carbide Nuclear Co., as a part of the Atomic Energy Commission's program to evaluate the feasibility of this type of reactor for the production of industrial power. The reactor vessel, including the core tank, was fabricated under contract by the Newport News Shipbuilding and Dry Dock Company.

An earlier, smaller reactor, the Homogeneous Reactor Experiment (HRE),[1,2] demonstrated the ability to produce substantial amounts of power, the inherent nuclear stability of the homogeneous type reactor resulting from the negative temperature coefficient of

reactivity, and the relative simplicity of operation, control and fuel handling.

Purposes of the present reactor, the HRT, include:[3]

1. Determination on a larger scale than the HRE, of the engineering reliability, in a reactor system, of both the conventional and relatively unconventional materials and components, including the reactor vessel and the zirconium alloy core tank;
2. Testing and demonstration of products for continuous chemical processing to remove reactor products;
3. Demonstration of the feasibility of the system as an operating power reactor.

It was necessary to design and build a reactor of substantial power output to accomplish these objectives within the confines of a definite construction schedule, and yet retain the flexibility, replaceability and moderate cost of an experimental system. For these and other reasons, it was determined that the reactor should have an operating heat output of 5 megawatts with a possible maximum of 10 megawatts, a specific power of 17 kw per liter, a core diameter of 32 in., a blanket (fluid) thickness of 14 in., a fuel outlet temperature of 300° C, and an operating pressure of 2000 psi.

The reactor vessel assembly is shown in Fig. 1. The 32-in. diam core vessel was fabricated from $^5/_{16}$- and $^3/_8$-in. thick plates of Zircaloy-2, a zirconium-tin alloy containing small amounts of Fe, Ni and Cr. The core tank fits approximately concentrically within the 60-in. ID pressure vessel, which is the main container for the 2000 psi operating pressure. This vessel is made of 4-in. thick carbon steel hemispheres (SA 212, grade B, manufactured to SA 300 practice), internally clad with a 0.4-in. thick layer of Type 347 stainless steel. The entire pressure vessel assembly is further contained within a $1^1/_2$-in. thick Type 304 stainless steel spherical blast shield, spaced 1 in. from the pressure vessel outer wall. The blast shield is a safety device intended to stop fragments in the improbable event of a sudden brittle failure of the pressure vessel. An aqueous solution of uranyl sulfate is circulated through the core vessel, through an external heat exchanger where steam is generated, through a pump and back to the core. Heavy water is circulated similarly through the annular space between the two vessels. This space is called the "blanket" space although the heavy water serves to reflect neutrons to the core.

It is not intended in this presentation to describe the fabrication of the entire assembly in comprehensive detail. Rather, the major objective will be to cover those problems which are of a special nature occasioned by the unusual requirements of design and application. These include:

1. Selection of materials of construction for the pressure vessel;
2. Fabrication of the heads and nozzles and flanged end connections to the pressure vessel;
3. Development of the closure joint weld for joining the hemispherical halves of the pressure vessel shell;
4. Fabrication of the blast shield;
5. Fabrication of the Zircaloy-2 core tank.

Pressure Vessel

General Considerations

The design and selection of structural materials for the reactor pressure vessel were influenced by the conventional requirements normally placed on pressure vessels by sound engineering practice, as represented by the applicable pressure vessel codes and standards, and necessary modifications of conventional design practice to accommodate special nuclear and operating requirements. We shall not attempt a complete justification here of the materials selected for the HRT pressure vessel, but some discussion is warranted regarding the factors which influenced their selection.

If neutron economy and minimum critical mass were the sole governing considerations, the ideal shape of a reactor would approach that of a sphere, but other conditions will generally dictate some modification of this basic shape. In any event, the diameter of a reactor vessel will approach the length of the vessel much more nearly than, for example, in the case of high-pressure chemical plants, where large capacities and minimum wall thicknesses of pressure containers are generally accomplished by increasing the length, to sometimes 100 ft or more, while keeping diameters down to a few feet or even inches. In the case of the HRT, it was possible to contain the reactor in the 5-ft ID spherical vessel, using a Code-approved pressure vessel steel, with a 4-in. wall thickness, although even this relatively small reactor vessel created some unusual fabricating problems. As one contemplates full-scale power reactors of several hundred megawatts capacity, the size, particularly the diameter of reactors, will soon require wall thicknesses and plate sizes which will tax, if not exceed, the capabilities of current practice in the fabrication of Code-approved pressure vessel materials. In addition to the selection of a material suited to both fabrication and service requirements, consideration had to be given to other factors which are either unique to reactors or peculiar to highly corrosive pressurized systems.

Radiation Effects

The pressure vessel of the HRT will be subjected to a rather intense fast neutron irradiation. It is known that such irradiation can, under certain circumstances, produce significant changes in the properties of some structural materials, but it should be emphasized that there is no certainty that such changes will necessarily occur to a damaging extent under all conditions of reactor operation. Among these changes are increases in hardness, tensile strength and yield strength, decrease in tensile ductility, and, of particular interest in pressure vessel carbon steels, an increase in the brittle impact transition temperature, together with a

possible decrease in the total impact energy resistance at temperatures above this transition. Our knowledge of radiation damage in structural materials is at present insufficient to permit prediction with complete confidence, of the ultimate performance of pressure vessel materials subjected to such radiation in operating environments. Nevertheless, we have some reason to hope that at operating temperatures, the embrittling effects of irradiation will anneal out at a rate such that a steady state condition will obtain below the danger limits for a brittle failure. In the absence of specific data to substantiate such an assumption, it was necessary to design the vessel on the basis of the worst possible conditions which might develop, whatever the opinions on the actual possibility of such an occurrence. Actually, one should probably consider the selection, design, and operations of the reactor vessel, at least in part, as a large-scale experiment to determine its radiation damage susceptibility in an environment representing a combination of all the factors existing in an operating reactor.

Thermal Stress

The high intensity of radiation incident on the vessel walls results in generation of an appreciable quantity of heat within the wall. Conduction of the heat to the surfaces of the plate develops temperature gradients in the wall. The conductivity of carbon steel is approximately twice that of stainless steel and hence thermal stresses would be roughly half as great in carbon steel. For this reason, carbon steel was preferable as the main structural material.

Materials

As a result of the above and other considerations, a moderately high-strength carbon steel, SA 212, Grade B, firebox quality, was selected for the principal structural component of the vessel. On the assumption—which may or may not be correct—that it should take longer to accomplish dangerous embrittlement of a steel with a lower transition temperature than if this transition temperature were higher, it was stipulated that the SA 212 material be made to fine grain SA 300 practice. The plate thickness, 4 in., required for the vessel, was in excess of that for which the steelmaker would guarantee the SA 300 low temperature impact values, but the final material actually did meet these test requirements. The carbon steel pressure shell is protected internally against corrosion by a 0.4-in. minimum thickness layer of Type 347 stainless steel, integrally clad to the base metal in the process of making the plate. The cladding, although produced to a customer specification, is essentially equivalent to SA 167, requiring a minimum of 18.0% chromium content and meeting a 0.0020 in./mo. maximum boiling nitric acid test corrosion rate in the sensitized condition.

Forming of Hemispheres

Because of the size and thickness of the heads, a combination of forming practices was required. The clad plates were heated to 2050° F and partially formed by pressing. Because of limited die size, this pressing operation affected only the center portion of the plate. These partially formed plates were reheated to 2050° F and transferred to a spinning machine in which forming started at 1950° F and continued down to 1450° F, at which point the heads were reheated and the spinning continued, three cycles being required to complete the forming. The finished formed heads were reflectoscoped to determine continuity of the bond and to check the thickness of the heads. The heads, after forming, were annealed at 1950° F, held 1 hr per inch of thickness, air cooled, annealed (normalized) at 1600 to 1650° F, held for 1 hr per inch of thickness, and again air cooled. The tensile strengths of the base metal and of the cladding after this forming and heat treatment, were approximately 78,000 psi and the shear strength of the bond was between 24,000 and 25,000 psi.

Fig. 2 Fabrication of vessel showing temporary rings and stand

Flanges and Connections

The six nozzle reinforcements are made of SA 212, Grade B, firebox quality steel, forged by the fabricator. The various flanges, transition pieces, rings and caps, associated with the six nozzles which connect with the interior of the vessel, are Type 347 austenitic stainless steel forgings, conforming to the chemical requirements of the vessel lining. The nozzle pipes are of seamless austenitic stainless steel tubing, also of the modified Type 347 composition, and the 30-deg elbow nozzle pipe fitting is of substantially the same type material. Bellows pipes are of modified Type 347 stainless steel seamless tubing, and the bellows elements and tangent bands are of modified Type 347 stainless steel sheet. All of the materials for the blanket outlet baffle assembly are made from modified Type 347 stainless steel bar and forgings.

Fabrication of Heads and Nozzle Attachments

Temporary support rings and pads, as shown in Fig. 2, were welded to each head to permit handling during

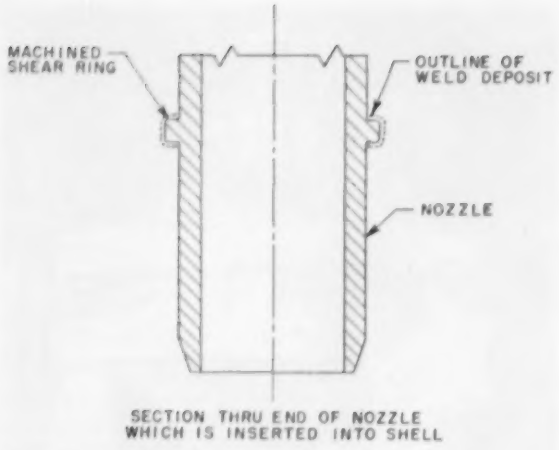

Fig. 3 Sketch of nozzle shear ring weld build-up

the fabrication of the vessel. Necessary surfaces were machined for reference purposes to permit location of the various joints, nozzles and flange faces. Nozzle openings were laid and drilled. The appropriate shell surfaces and nozzle reinforcement pads were machined for welding. The pads were then welded to the heads, after which the heads were stress relieved at 975° F for 16 hr. This stress-relief anneal is somewhat lower than normal practice, but is within permissible limits set by the Code. The lower temperature was used to minimize the possibility of sensitization of the stainless steel in the vicinity of the nozzle openings. Corrosion tests indicated that this treatment does not impair resistance of the stainless steel to general corrosion or to intergranular attack.

The joint face of each head and the face of the temporary support ring were remachined and all nozzle openings were bored and grooved to receive the nozzle pipes. The reinforcement pads were then finish faced. The stainless steel flanged nozzles which had been purchased as rough machined forgings were then premachined for assembly in the shell. The holes for pipe connections were located and drilled and the prepared ends of the pipe connections were inserted and welded into place. The pipe connections were then drilled to depth and size. The plain nozzles were cut from pipe, and shear rings, shown in Fig. 3, were built up by welding on the outside of the nozzles. The nozzles were then machined for assembly into the shell. The various nozzle, pipe and bellows assembly connections were then welded into place. In the welding of the stainless steel, the inert-gas-shielded tungsten-arc process was used on all weld surfaces which were to be in contact with the corrosive process fluid. Where this surface was the root pass of a weld, a preplaced consumable insert was used. Where the face of the weld was to be in contact with process fluid, the final $^1/_8$ in. or more of weld metal was deposited by the tungsten-arc method. The manual metallic-arc process, using covered electrodes, was employed in all other parts of pressure joints and throughout all the joints in certain of the nonpressure carrying parts. The root insert and the bare filler wire conformed to A 371–53T, ER 347. Coated electrodes for the manual metallic-arc process conformed to A298–48T, class E347–15, with a minimum chrome-nickel ratio of 1.9 specified for the weld deposit. In cases where stainless steel and carbon steel were welded to each other, covered electrodes conforming to MIL-E-16715A (Ships), Type MIL-310–15 were used. In the tungsten inert-gas process, the welding current was d-c straight polarity, and d-c reverse polarity was used for the manual metallic-arc process. Inert gas protection of the internal surfaces of the stainless steel welds was provided in all cases prior to and during the welding operations. No preheat or postheat was used, and the interpass temperature was kept below 200° F. Joint details and bead sequence are as shown in Fig. 4. Those involving joints between carbon steel and stainless steel in nozzles and cladding, are as shown in Fig. 5. All joints were inspected visually prior to welding, and each completed root bead was examined visually under 20 power magnification. A liquid dye-penetrant inspection was used on the inside and outside of all finished welds after any required grinding or machining. All dye-indicated defects were repaired by grinding or chipping and rewelding. Wherever possible, all joints in pressure-carrying parts were subjected to complete radiographic inspection in accordance with the techniques of UW-51 of the Code. This was done after the first three beads deposited in the root of the joint and also on completion of the welding and machining or grinding of the joints. No radiographic defects of any sort were permitted in the first three beads of any joint, and the completed welds were required to have no porosity, slag or other inclusions greater than size medium or in excess of half the amounts permitted by the applicable Code porosity chart.

After the installation of the various nozzles, bellows assembly, purging baffle and blanket outlet baffle, the Zircaloy-2 core tank, whose fabrication will be mentioned briefly later, was positioned in the outlet head,

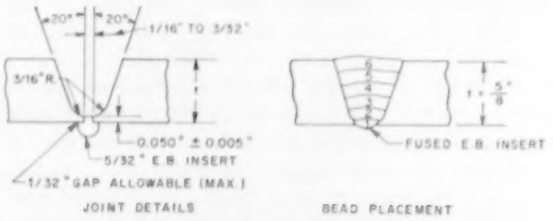

Fig. 4 Welding data for 347 stainless steel

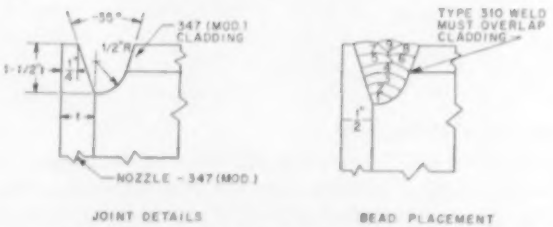

Fig. 5 Welding data for dissimilar metal joints at nozzles

Fig. 6 Assembly of core vessel and pressure vessel during fabrication of the homogeneous reactor test unit

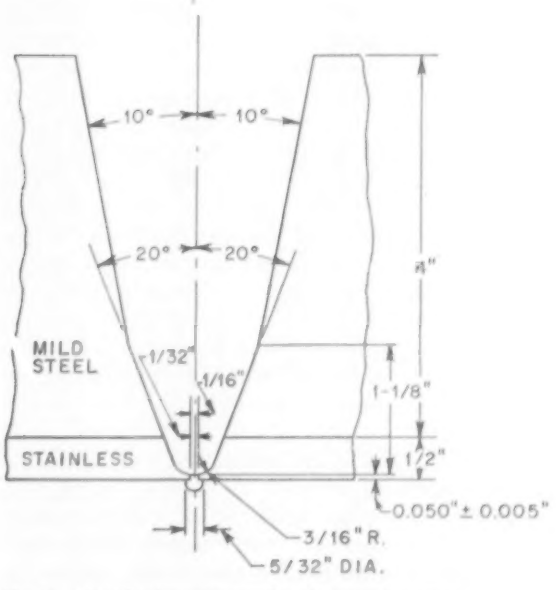

Fig. 7 Weld-joint preparation for vessel closure

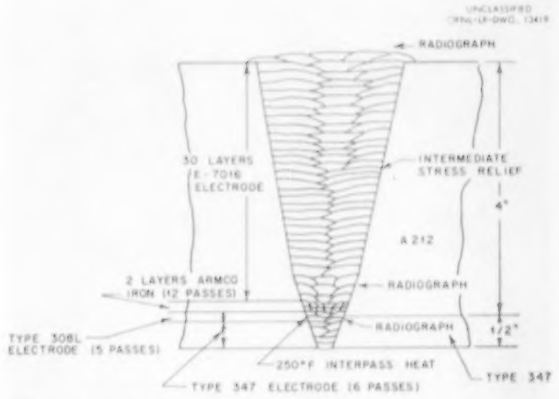

Fig. 8 Closure joint bead sequence

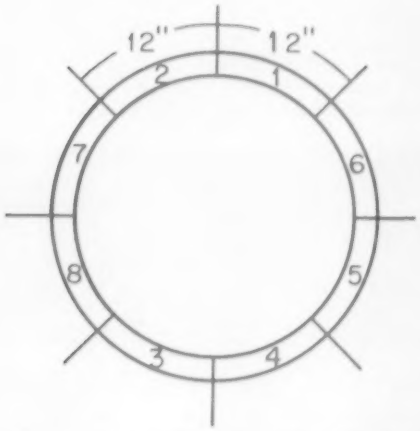

Fig. 9 Pressure vessel closure joint segment welding sequence

appropriately supported, and the inlet shell was positioned and mechanically fastened so that a $^1/_{16}$-in. spacing was maintained between the two heads of the weld nose preparation. The entire vessel was then placed in the horizontal position, and both ends of the core tank were aligned concentric with the bores of the fixed flanges on the heads. The core tank outlet flange was then welded to the core tank using the methods mentioned later for the welding of Zircaloy-2. After completion of this operation the heads were separated, the core tank was positioned in its normal relationship with the outlet head, and the blanket outlet baffle was reassembled in place (Fig. 6). The two heads were then assembled with the insert strip in place for final closure joint welding.

Since the inner surface of the closure joint was inaccessible, all welding on it had to be done from the outside. The first pass involved inert-gas-shielded tungsten-arc fusion of the preplaced Type ER 347, A371–53T insert. The weld joint preparation was as shown in Fig. 7. The bead sequence used in the procedure qualification, Fig. 8, was essentially that used in the actual welding of the vessel, with the joint divided into segments, Fig. 9. The first step involved tack welding the Type 347 insert to one of the hemispheres. The hemispheres were then assembled and the insert tack welded to the other hemisphere without rotating the vessel. The welded insert was fused in block No. 1, inspected and followed with the second bead. This

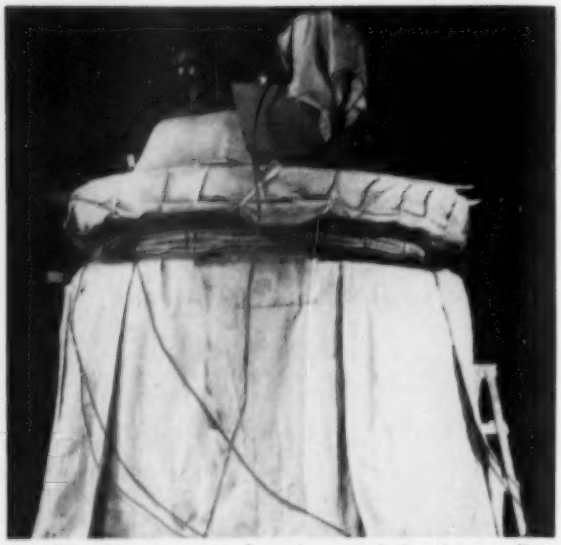

Fig. 10 Arrangement of equipment during intermediate stress relief of closure joint in pressure vessel

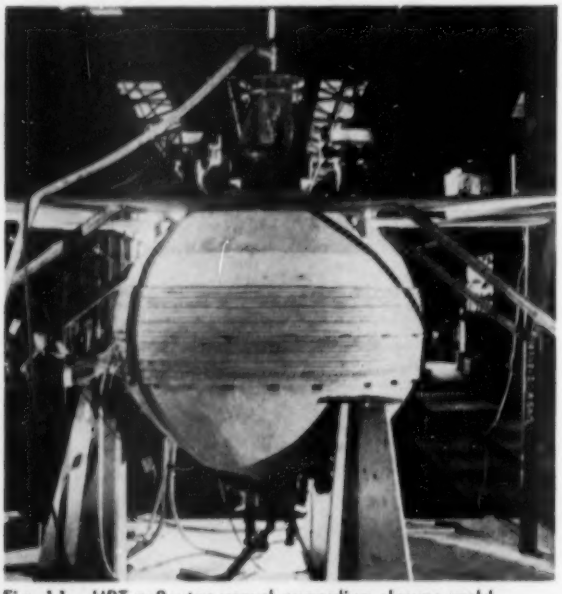

Fig. 11 HRT reflector vessel annealing closure weld

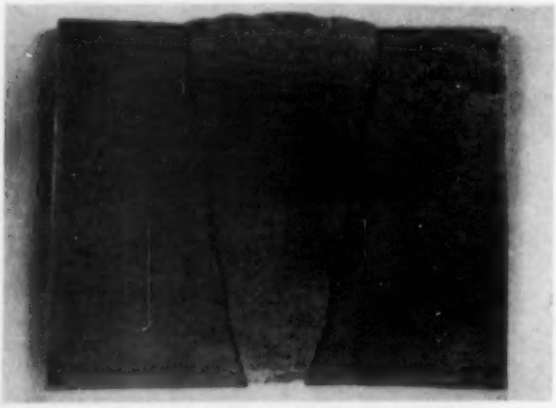

Fig. 12 Macroetch section qualification test joint

was repeated in block No. 2, joining the beads in block No. 1. The third weld bead followed in blocks 1 and 2. This procedure was repeated in the successive blocks of the diagram, with the vessel rotated so all welding was done from the top. In the subsequent welding, the same sequence was followed, the vessel being rotated after completion of each layer. When the 347 weld deposit was within $^1/_{16}$ in. of the base metal cladding interface (passes 5 and 6), two layers or more of Type 308L electrode were deposited to build the deposit up to the interface. All indicated defects at this point were repaired. Then followed two layers (passes 12 through 23) of covered Armco iron electrode, using small stringer beads and low amperage. The joint was then completed with E-7016 electrode, stopping at half the depth of the groove for intermediate stress relief.

For the tungsten inert-gas process, d-c straight polarity was used. Direct-current reversed polarity was used for the manual metallic-arc covered-electrode process. Particular care was exercised in making the transition layers to insure a minimum dilution of the Armco iron with the stainless steel. The inner surface of the weld was protected against oxidation by an inert gas during the welding of the root bead and the next two succeeding layers. No preheat was used during the welding of the stainless portion of the joint. The base metal was maintained at not less than 150° F during welding of the carbon steel, with the Armco iron weld deposit considered a part of the carbon steel portion of the joint. The interpass temperature did not exceed 200° F during the stainless steel welding, and was not less than 150° F while welding the carbon steel portion.

The stress relief at mid-point of the weld, involved local induction heating of a band approximately 20 in. wide, including the welding groove. The heat was applied at a rate not over 80° F per hour, to a temperature of 975 ± 25° F, and this temperature was maintained for 10 hr. Figure 10 shows this operation. The base metal and weld were then allowed to cool at a rate not in excess of 100° F per hour. The base metal outside the heated band was protected from severe temperature gradients by thermal insulation during stress relieving. Throughout this stress relieving the zirconium core tank was kept cool by filling with tap water and maintaining a small flow through it. The pressure vessel itself was filled with inert gas during the stress relief operation, to protect the stainless cladding from oxidation.

After completion of the closure joint weld and radiographic inspection, the weld and adjacent metal were given a similar stress relief, except that temporary structural encumbrances were removed in the final stress relief, and the holding time at 975° F was increased to 25 hr. This is shown in Fig. 11.

The joint was inspected visually prior to welding, and visual inspection was maintained throughout the welding operations. Completed root beads were examined under 20 power magnification. Magnetic inspections of the welds and base metal were made period-

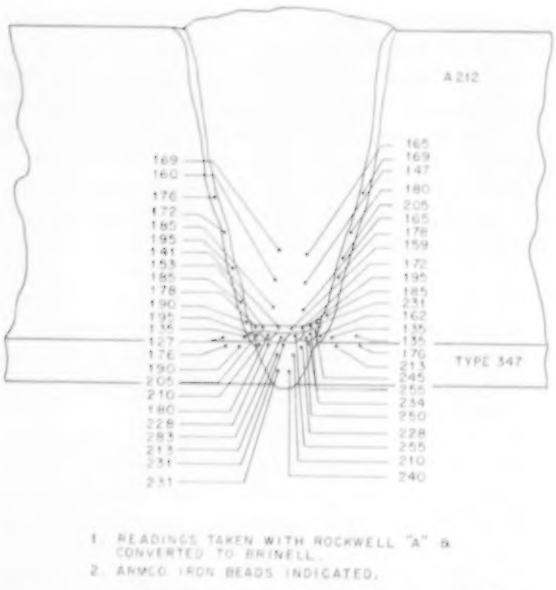

Fig. 13 Pressure vessel closure joint procedure qualification test hardness survey

ically throughout and after completion of the welding. Radiography was employed after the completion of the first three stainless steel passes, after the completion of all stainless steel welds, and after completion of the closure joint. The radiation source, cobalt-60, was located in the center of the sphere, inside the core tank, and the film to be exposed was placed on the outside of the vessel or in the weld groove. The first three stainless steel passes were required to meet the same porosity-free standards indicated previously. Subsequent radiographs were required to show no cracks, and no porosity or inclusions larger than size medium or more than half the amount allowable in the appropriate porosity charts of the Code. The completed closure joint was ultrasonically inspected before and after the final stress relieving operation.

Figure 12 shows a macro-etched section of the qualification test joint. Figure 13 shows a Brinell hardness traverse of the section.

After final stress relief, the outlet and inlet covers were assembled on the pressure vessel, all nozzles were interconnected and a hydrostatic test pressure of 4000 psi was held for one hour, Fig. 14. The vessel was also subjected to a helium leak test.

The vessel was independently inspected by an Insurance Company Code inspector and stamped with the Unfired Pressure Vessel Code symbol.

Blast Shield Fabrication

The blast shield shell was fabricated into two hemispheres by forming and welding plate segments as shown in Fig. 15. Each hemisphere consists of 6 segments and one center disk, formed from 1⁵/₈-in. thick SA 240 plate, Grade S, Type 304 stainless steel. The top hemisphere was cut into three segments, and the entire shield was then assembled around the pressure vessel

Fig. 14 Homogeneous reactor test reflector vessel before installation of blast shield

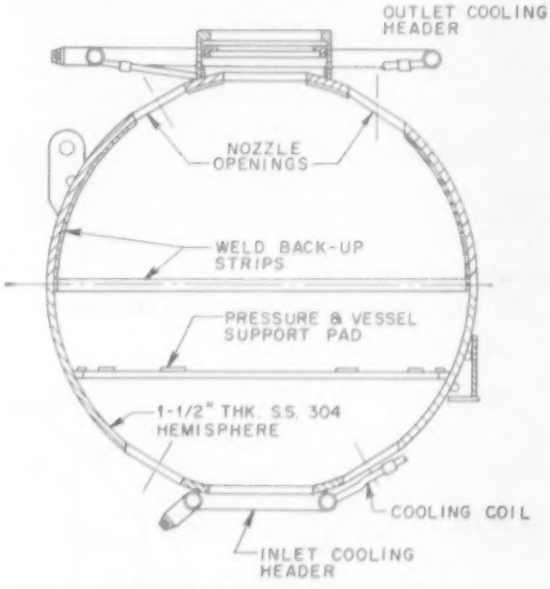

Fig. 15 Sketch of blast shield

and welded using Class E308–15, A292 covered electrode. The procedure was designed to achieve a quality of weld comparable to that used in welding the Type 347 stainless steel attachments to the pressure vessel. After assembly and completion of welding of the joints

Fig. 16 HRT reactor assembly loading for shipment

of the blast shield, the cooling coils were wrapped around the blast shield, tacked in place and welded to the headers. After preliminary hydrostatic testing, the full attachment welds were made between the coils and blast shield. The completed pressure vessel, with blast shield and cooling coils attached, is shown in Fig. 16.

Zircaloy-2 Core Tank

The fabrication of the 32-in. diam Zircaloy-2 core tank has been described previously[4] in some detail, and only a brief description of the tank and welding techniques will be included here. The performance of this zirconium alloy core tank is one of the major experimental unknowns to be determined in the operation of the HRT. There has been no prior experience with a vessel of this material in a comparable environment and the schedule for completion of the reactor did not permit prior experimental evaluation of all the metallurgical, corrosion and engineering factors involved in determining the adequacy of this material for the core. Consequently, it is entirely possible that substantial modifications or substitutions may have to be made in the core tank in the course of the homogeneous reactor development program.

The vessel was fabricated from $^{3}/_{8}$- and $^{5}/_{16}$-in. Zircaloy-2 plate, formed and welded as shown in Fig. 17. Zircaloy-2 is a zirconium alloy containing approximately $1^{1}/_{2}\%$ tin and smaller quantities of iron, nickel and chromium. It is similar to titanium in the welding problems involved, in that complete shielding in a high purity inert atmosphere is required to achieve a reasonably ductile weld, free from interstitial contamination by oxygen, nitrogen, hydrogen or carbon. Considerable care had to be exercised in forming the plates to avoid contamination as well as to achieve a metallurgical structure combining strength with reasonable ductility. The forming was carried out at temperatures in the alpha range, and the formed sections were given a stress-relief and recrystallization anneal at about 1200° F. The welding was accomplished by the use of the inert-gas-shielded tungsten-arc method, using helium as the primary torch gas, and a specially designed external trailing shield contoured for each joint, with provision for introducing filler metal through a quartz glass viewing window. All the operations were made as nearly mechanical as possible, the work being moved under the shield and torch during welding using a machine carriage or a weld positioner, as appropriate. Shielding gases were introduced into the shield through a diffusion chamber and distributing tubes. This is shown in Fig. 18. The root passes of

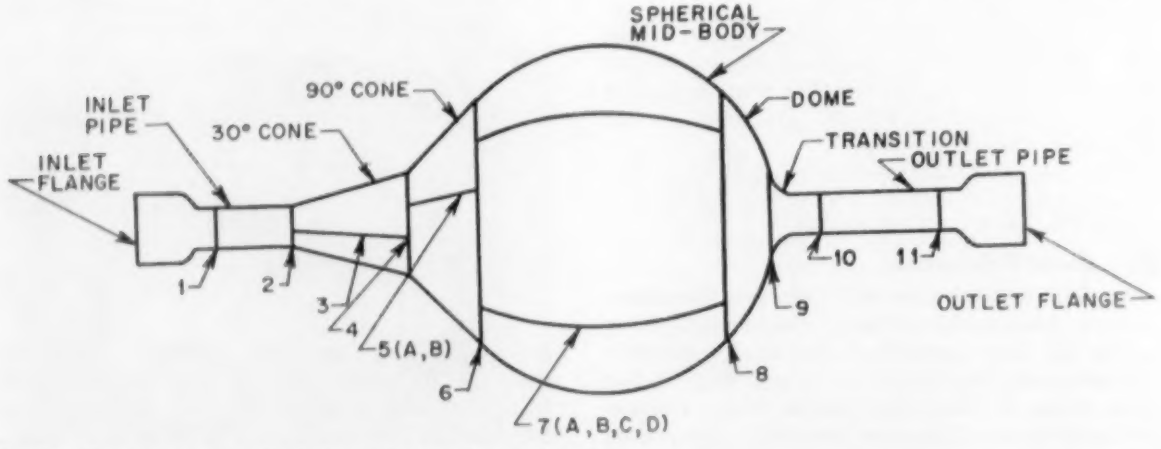

Fig. 17 Homogeneous reactor test core tank sections and joints

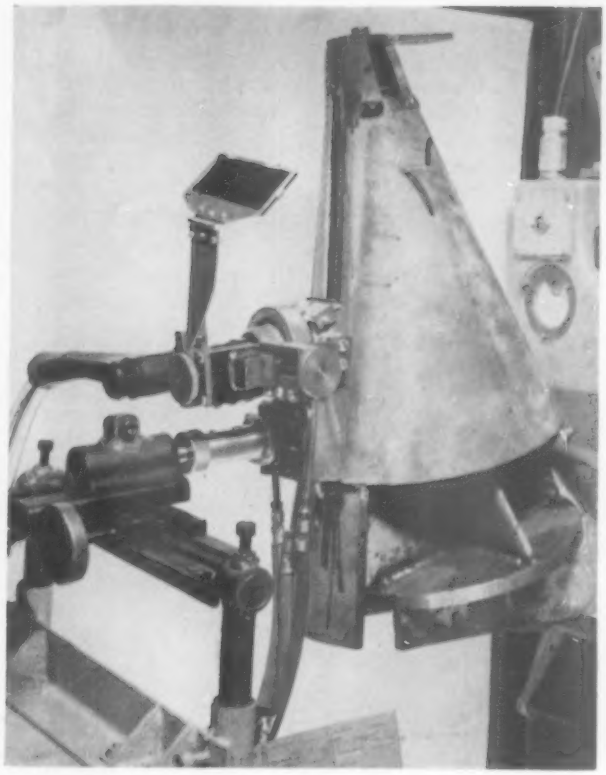

Fig. 18 Side-top view showing arrangement for making seam welds of 30° cone section of core tank. Note end tabs and completed weld

all Zircaloy-2 weld joints were made using preplaced consumable inserts. Filler metal was added in all subsequent passes. All joints in the Zircaloy-2 were radiographed.

Despite the high operating pressure of the system, the differential pressure across the core tank wall is normally balanced. However, the core was designed to withstand a pressure differential external or internal of not over 300 psi in the event of fluctuations due to unusual operating conditions at temperature. The core has been pressure tested at 770 psi at room temperature. The completed core tank is shown in Fig. 19.

The completed reactor vessel assembly has been delivered to Oak Ridge where it is being installed in the reactor system scheduled to begin preliminary test and operation this year.

Fig. 19 Core vessel for homogeneous reactor test fabricated entirely of zircaloy-2 material

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DISCUSSION BY ROBERT J. KELLER

I would like to take this opportunity to congratulate the authors on the excellent manner in which this paper was prepared and presented.

I believe this paper clearly illustrates that engineering advances such as described can only be made by careful planning of the project, including design, selection of material and welding processes, and by rigid supervision of the execution of this plan.

The various personnel involved in the fabrication of

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this project must have been faced with a number of unknowns at the start of their work. However, by application of sound engineering principles which included selection of materials which were satisfactory for both product and fabrication, selection of welding processes which reflected the latest and best techniques, as well as using a design which was conducive to good welding practice, they were able to complete this reactor within the confines of their original objectives, which were namely, conformation to a definite construction schedule, retention of flexibility and replaceability in their design, and the achievement of a moderate cost of an experimental system.

One item of particular interest was the welding procedure used in the closure welds of the pressure vessel, which was 4-in. Type 347 stainless clad on 4-in. thick Type A-212 steel, where a weld was made in which the welding was done from one side only, using two welding processes and four types of welding electrodes in the same groove.

Their procedure for welding this stainless-clad heavy-walled plate from one side, by using the consumable type chill with tungsten arc, followed by manual welding of the next layers with Type 347 electrodes until the weld was close to the top of the cladding, then two layers of low-carbon Type 308 electrodes, followed by layers of Armco iron deposits and completion of the joint with 7016 electrodes, is a relatively new procedure of welding. I believe that it would be of interest to the general public to learn of the exact testing procedure which was used by the authors to qualify their procedure and, if possible, to make known the results of the various tests conducted in the qualification of this procedure.

It would also be of interest to know the reason for the use of the standard stainless steel backing which was used in the construction of the blast shield instead of using a consumable chill, such as was used for the pressure vessel fabrication.

I believe it would also be of interest to learn of any difficulties which might have been encountered in the fabrication of this reactor, especially in respect to any repairs which might have been required in the welds, and whether repair welding in the dissimilar materials used presented any problem.

I am sure this paper is of interest to a great number of people who have the problem of fabricating articles from dissimilar materials, and I would again like to compliment the authors of this paper on a job well done.

AUTHOR'S REPLY

The authors are indebted to Mr. Keller for providing an opportunity to further develop an interesting phase of the work done during development of the procedures necessary to fabricate the subject reactor, since enlargement of this topic did not seem proper in the paper.

The closure joint was qualified in accordance with ASME Code, using materials which met the requirements of the code specifications. The desire to so qualify the joint imposed the large problem of obtaining an austenitic-ferritic transition zone in the weld which would be sufficiently ductile to pass the bend test requirements, since tensile requirements would be no problem.

For this reason, the criterion used throughout the development work on the closure joint was the relative ability of the various experimental techniques to produce acceptable bend tests in the transition area.

The use of extra low-carbon ferritic electrodes in the transition layer, while new, was not original. It was found to be extremely difficult to hold dilution in the first layer of ferritic weld to an acceptably low level until a buffer layer of low-carbon 18–8 was used over the Type 347 deposit.

This expedient, combined with the use of low current density on the Armco iron electrodes and a technique which consisted of welding small stringer beads at high travel speed, was found to provide a better answer to the problem than any of the five or six other methods conceived originally.

It was found that a transition zone which was free from fissures in the Armco deposit and in which the stress-relieved hardness did not exceed 300 Brinell would readily bend without tearing. With these criteria established, a great many experimental joints were welded acceptably before formal qualification was attempted.

This technique is not recommended for general production use since it requires an exacting degree of supervision, welder training and, chiefly, welder skill.

In reply to Mr. Keller's question as to why a backing strap was used on the closure joint in the stainless blast shield in preference to the consumable insert, we may say that the insert was never considered for this joint. The smoothness afforded by the insert was not required in this joint, since there were neither flow nor corrosion considerations on the blast shield.

The further question regarding difficulties encountered in the fabrication of the reactor can only be answered by saying there were none. The entire project was considered experimental and was handled as such rather than in a general production manner, i.e., there was constant supervision of every phase of every operation by a qualified engineer. The difficulties came before the fabrication started and, because of them, problems on the job were minimized. However, the prospect of making a repair in the closure joint was foreseen and such a repair was made experimentally with success but the need did not arise to use this technique on the actual closure joint.

Making end plate to dummy fuel channel weld

FUSION WELDING ZIRCONIUM FOR A NUCLEAR REACTOR

Tooling and techniques developed to permit the welding of large zirconium assemblies on a production basis

BY BRUCE L. BAIRD

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Presented at the 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7–11.

The Reactor

The Atomics International Division of North American Aviation, Inc., is now building a nuclear power reactor that will employ liquid sodium as the cooling agent and graphite as the moderator. The peak heat load of the reactor will be about 20,000 kw, permitting the generation of approximately 7500 kw of electricity.

The basic units of the core of the reactor will be moderator cells consisting of hexagonal-shaped graphite blocks canned in zirconium. Figure 1 is a photograph of a section of graphite used in making up a short graphite-loaded can section for tensile testing. The

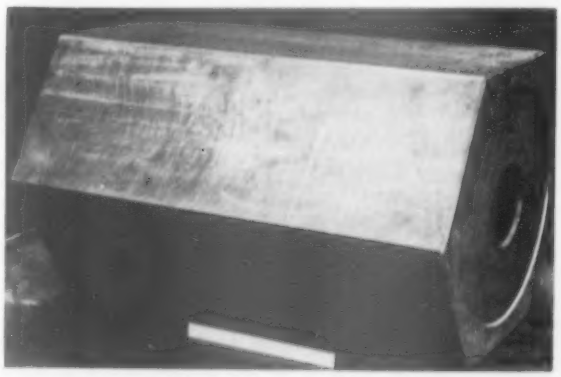


Fig. 1 Short graphite moderator

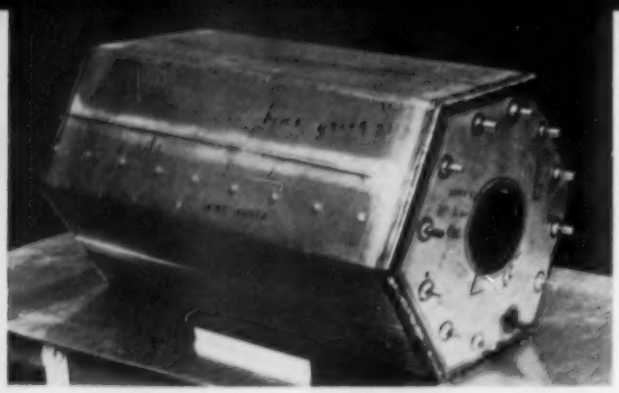


Fig. 2 Short moderator assembly (graphite moderator enclosed in a welded zirconium can)

Fig. 3 Full-length zirconium moderator can shell

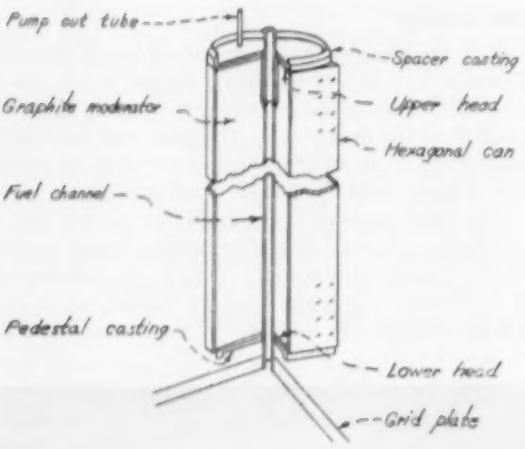


Fig. 4 Complete moderator cell

completed can, before testing, is shown in Fig. 2. Figure 3 is a photograph showing a full-length zirconium moderator can shell.

All of the components of a completed moderator cell are shown in Fig. 4. In operation, a low-enrichment uranium fuel rod will be located in the fuel channel in the center of the cell. The heat generated by the uranium will be carried off by circulation of molten sodium through the fuel channel. Secondary heat generated in the moderator will be carried off by circulation of sodium between the cells.

The individual moderator cells will be arranged in a honeycomb pattern to make up the core of the reactor, as illustrated in Fig. 5. A clearance space will be maintained between the cells to allow passages for the flow of sodium. Some cells will be scalloped at one or more corners. Control and safety elements will extend downward into the channels formed by the scalloped corners of three adjacent cells.

Zirconium—Its Use and Limitations in Reactors

Zirconium was selected for use in the reactor because of its good corrosion resistance, good high-temperature strength and low absorption cross section for thermal neutrons.

The use of this metal, however, brought about the problem of coping with its instability during welding. Heretofore almost all successful welding on zirconium had been accomplished in an isolated atmosphere box. This technique restricted the use of zirconium to assemblies relatively small in size.

In building the sodium graphite reactor, it was necessary to develop the tooling and techniques that would permit the welding of large zirconium assemblies on a production basis. This paper contains a review of the conclusions drawn from the welding development program which made this possible.

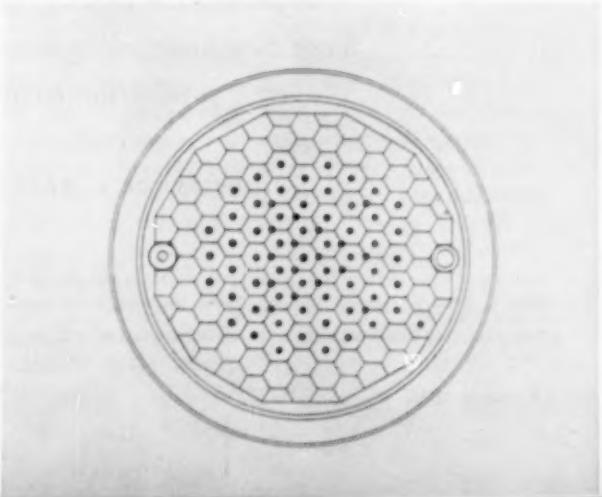
Zirconium—General Information on the Metal

Though rarely found in the free state, zirconium is a common element. It ranks eleventh in the list of elements in the earth's crust, being more abundant than such elements as copper, lead, nickel, and zinc. In the pure state it is a metal exhibiting good ductility. It combines, however, very readily with oxygen and nitrogen, and in so doing becomes hard and brittle. It is a sister metal to titanium. Many of the physical and chemical properties of both metals, which affect weldability, are similar or identical.

Commercially pure zirconium has an ultimate tensile strength and hardness about 20 per cent greater than low-carbon steel.

The metallurgical, physical and mechanical properties of as-rolled zirconium vary greatly with the purity

Fig. 5 Reactor core arrangement



of the metal. The as-welded properties vary likewise. The properties of the weld are influenced by three factors; the original purity of the ingot (especially with regard to oxygen, nitrogen, and hydrogen content), the amount of contamination introduced in rolling the ingot, and the amount of contamination introduced during welding.

Preproduction Research and Development Program

Before zirconium assemblies of the reactor went into production, a pilot run for converting ingot to sheet was made and a two-phase program of welding research and development was completed. The first phase of the welding program involved the making and testing of welds simulating all moderator can joints. This included manual butt, stud, and corner welds, and automatic butt welds. Based on the results of these tests, recommended welding techniques and standards of weld acceptability were determined, and specifications governing moderator can welding were written. The second phase involved the manufacture and testing of pilot assemblies, as a check on the conclusions drawn from the initial phase, and as a check on the specifications.

It was the goal of Phase 1 of the investigation to develop procedures and techniques which would yield welds with physical and mechanical properties approaching those of base metal. This required that hardening, due to contamination by atmospheric gases during welding, be held to an absolute minimum.

A major task in developing these procedures was the evaluation of speculation, based on theory and hypothesis, about the significance of such characteristics as the color of the weld. (The importance of the color was evaluated in the initial stages of Phase 1 by a study of published results of research on the characteristics and composition of zirconium heated in air, and re-evaluated in later stages by running actual mechanical tests on welds of various colors.) Most of the speculation could not be substantiated by tests; therefore, as time progressed it became apparent that, employing the correct tooling and welding techniques in conjunction with the inert-gas-shielded nonconsumable-electrode welding process, large zirconium components could be successfully welded on a production basis.

All of the welds discussed in this paper were made on sheet material that was rolled from ingots of 99.8% pure, hafnium-free zirconium. The introduction of impurities in the course of converting the ingots to sheet was maintained below a certain maximum level correlated to a maximum allowable surface hardness after rolling. The maximum allowable hardness for material to be used for the fabrication of reactor components was set at Rockwell A 55.5. Materials used for preproduction experimental test welds were slightly harder, averaging about R_A 57.5. Two additional significant properties of the test weld material were an ultimate tensile strength of about 72,000 psi, and a minimum bend radius of about 2.5 times the material thickness. It should be remembered that data collected from welds made on this material would not necessarily correlate with data collected from welds made on zirconium of a different purity.

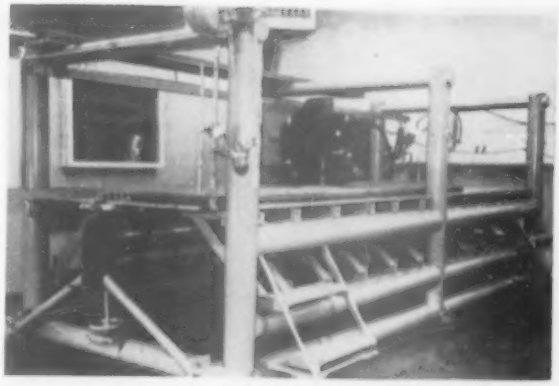


Fig. 6 Automatic welding fixture

Phase 1 of Preproduction Program

Requirements

It was required of Phase 1 of the preproduction investigation that the following items be determined:

1. The arc welding process to be selected for welding the moderator cans.
2. The detailed requirements of the selected process such as type and magnitude of weld current, inert-gas flow rate, arc voltage, travel speed, etc.
3. The jigs, fixtures, and accessory welding equipment required.
4. The requirements of acceptable welds such as shape and color, maximum allowable porosity, hardness, ultimate tensile strength, and minimum bend radius.
5. The shrinkage characteristics of the welds.
6. The clearance required between carbon and zirconium to prevent carbon pickup and embrittlement in welding the can ends on graphite loaded can shells.
7. The amount the welds would work harden if repairs were peened.

Selection of Welding Process

Present welding technology offered a selection of only two processes for making the welds on the moderator cans. These were the consumable and the nonconsumable electrode inert-gas-shielded arc processes. The nonconsumable (tungsten-arc) process was selected because of an availability of more data on welds made by this process, on materials such as titanium, aluminum, and magnesium; and because a source of consumable zirconium electrode material was not available.

Equipment

Utilizing experience gained previously on welding titanium, a welding fixture was designed and built for making the longitudinal seam welds on the moderator cans. The fixture, shown in Fig. 6, employs a reworked gun barrel and support and chill. It contains a grooved

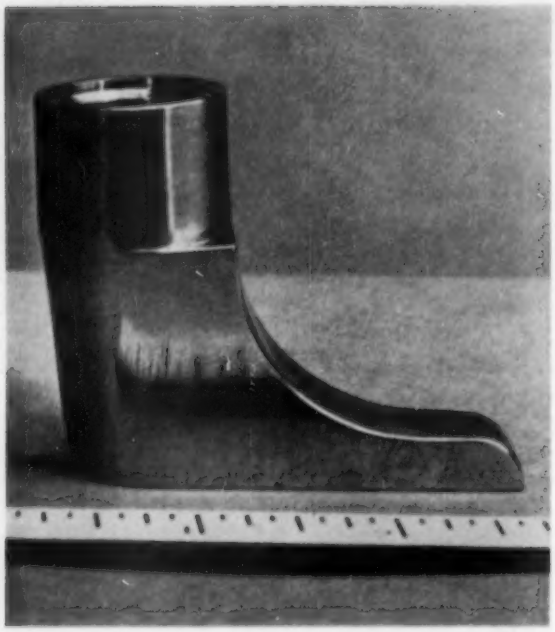


Fig. 7 Trailer gas cup

Fig. 8 Controlled atmosphere chamber

copper backing bar mounted on the top of the gun barrel. Holes were drilled along the centerline of the backing groove to permit the introduction of an inert gas to the bottom side of the weld. Pneumatically operated hold-down fingers were used to maintain firm, uniform contact between the material to be welded and the backing bar.

This jig was used in making all of the preproduction automatic test welds in addition to the longitudinal seam welds on the development and production moderator cans. Inert-gas coverage was maintained over the top of all automatic welds by delivering the gas to the weld zone through a trailer cup of the shape illustrated in Fig 7.

No method of chill was used for making the manual test welds or the manual welds on the development moderator cans. With the exception of one particular group of manual test welds (discussed in the following paragraph) inert gas was delivered to the top side of the weld through a standard $^1/_2$-in. I.D. inert-arc torch nozzle. When used on the manual welds, backing gas (for weld root coverage) was either directed from a $^1/_2$-in. I.D. tube to the under side of the molten puddle by a welder's helper or was maintained on the under side of the joint by an enclosure of one sort or another.

One group of manual test welds was made in the inert-gas-filled chamber shown in Fig. 8. It can be considered that these welds received an amount of inert-gas shielding approaching the maximum obtainable. Three complete purges of the atmosphere were made with inert gas prior to welding, and the gas pressure was maintained at 3 lb in excess of atmospheric, during welding.

A selenium rectified, three-phase, saturable reactor-controlled transformer with a remote-control current selector and a high-frequency starter was used as a source of welding power for both manual and automatic d-c welds. To avoid excessive heat concentration at the tungsten electrode, only straight polarity current was used. A-c welds were made using a balanced wave transformer type welder as a source of power.

Fig. 9 Restrained bend test specimen

Tests Made During Phase 1

A number of tests were made during Phase 1 of the preproduction investigation. To determine (*a*) required inert gas coverage, (*b*) if color could be depended upon as a criterion for judging whether or not a weld had been hardened excessively, (*c*) acceptable and rejectable weld colors, (*d*) acceptable and rejectable weld contours and (*e*) if porosity could be introduced in a weld by inadequate gas coverage, the following welds were made: (1) manual butt welds made with and without backing gas, (2) manual butt welds made in an inert-gas-filled chamber (see lead photograph), (3) automatic butt welds

made at a constant travel speed while shielding gas flow was varied in increments. These three types of weld were examined visually for color and contour, and were hardness, tensile, restrained bend (see Fig. 9), and minimum bend radius tested. In addition, they were inspected radiographically.

To determine the relative merits of the use of alternating or direct welding current, automatic a-c and d-c butt welds utilizing various weld settings were made and tensile, minimum bend radius, and hardness tested. Welds of both types were radiographically inspected.

To determine weld settings (i.e., current voltage, travel speed, etc.) and techniques which would yield optimum manual and automatic welds, and to determine the mechanical properties of these optimum welds, automatic butt and manual butt, stud and corner welds were made. These welds were tensile, hardness, minimum bend radius and restrained bend tested.

To determine limitations on weld porosity and to determine acceptable and rejectable porosity standards; hardness, tensile and minimum bend radius tests of porosity-free automatic butt welds were compared with these same tests on welds containing light scattered porosity.*

To collect data on required preweld cleaning techniques, radiographs of automatic butt welds cleaned by various degrees by various methods were studied.

To determine if porosity could be removed by refusing the weld nugget, multipass automatic butt welds were made and radiographed between passes. The radiographs were then compared.

To determine weld shrinkage, pre- and postweld dimensional checks were made on weldments containing butt welds made by both the automatic and manual processes.

To determine the required amount of clearance between carbon and weld joints, manual butt welds were made in direct contact with carbon and with 1/16-in. clearance between carbon and weld. These welds were hardness, tensile and minimum bend radius tested. In addition they were radiographed and analyzed for carbon content.

To determine the effect of peening, hardness, tensile and minimum bend radius tests were made on automatic butt welds before and after severe working with a planishing hammer.

Conclusions Drawn from Phase 1 Tests

The following significant conclusions were drawn from the data collected in Phase 1:

1. Welds having mechanical properties equal to or better than base metal can be successfully made. Using the right combination of chill and inert-gas coverage, welds softer and more ductile than base metal can be made. Welds made on zirconium of equal purity to the metal used in this investigation do not show a tendency to age embrittle under restrained bend testing.

2. Automatic butt welds on 0.035-in. thick material, free from discoloration, with no undercutting, 100% penetration and less than 0.005-in. sag can be made using the weld fixture shown in Fig. 6, direct current and travel speeds of 4–32 ipm. Identical alternating current welds can be made on the weld fixture only at speeds of 4–6 ipm, since it is necessary to hold alternating currents to low values to avoid fusing the tungsten electrode. (DC was selected over ac for making the moderator can welds because of its greater versatility. Mechanical tests showed no significant difference in the mechanical properties of a-c and d-c welds.)

3. Zirconium, from the standpoint of the welder, is an easy material to weld, provided the correct combination of chill and inert-gas shielding is used. When the correct welding technique is employed, the molten metal flows easily and shows little tendency to crack in the course of cooling.

4. Cooling rate (as controlled primarily by chill) is a highly significant factor in minimizing contamination of the weld by oxygen and nitrogen, but has no direct effect on the metallurgical structure of the weld deposit (pure zirconium has two allotropic forms but transformation cannot be suppressed by cooling rate).

5. The presence of discoloration, of certain types, on the surface of the weld does not necessarily indicate that oxygen or nitrogen has penetrated into the body of the weld. It does not necessarily indicate that the ductility or hardness of the weld has been adversely affected by excessive oxygen or nitrogen contamination. Color cannot be depended upon as an absolute criterion for judging whether or not a weld had hardened excessively. Excessive hardening can occur although neither discoloration nor porosity are present on and in the weld. Rockwell hardness surveys of welds of different colors, made under different conditions, demonstrate the limitations of using color as an absolute standard of acceptability. Neither visual nor X-ray examination, nor a combination of both, are sufficient to indicate that hardening of a weld has not occurred. To insure against hardening, sample welds must be hardness tested and, when required, weld variables must be adjusted accordingly.

6. The absence of a metallic luster on the surface of the weld deposit indicates that an excessive amount of hardening and embrittling due to contamination has occurred.

7. Welds completely free from discoloration are very difficult to make without adequate chill.

8. Little or no porosity is introduced in the weld by incomplete gas coverages. It is likely that all of the oxygen and nitrogen which dissolves in the molten weld puddle remains combined as zirconium oxide or nitride, after solidification. Therefore none is available to precipitate out of solution as the weld cools.

9. Fine scattered porosity does not, to a significant extent, have an adverse effect on the tensile strength or minimum bend radius of the weld.

10. The presence of porosity in the weld indicates primarily poor joint cleaning rather than poor inert-gas shielding. Radiographs show a definite correlation between poor weld cleaning and the incidence of porosity.

* Evenly distributed pores no larger in size than 0.010 in.

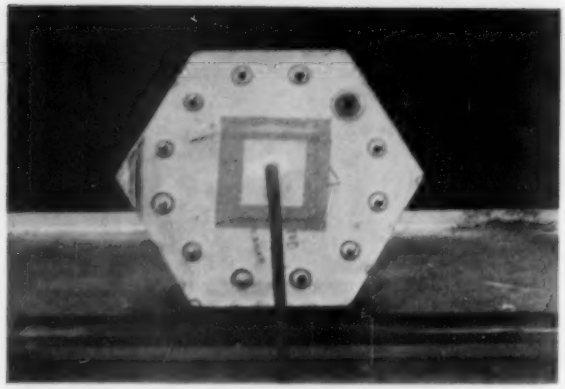


Fig. 10 End view showing application of backing gas to end plate-to-can shell welds

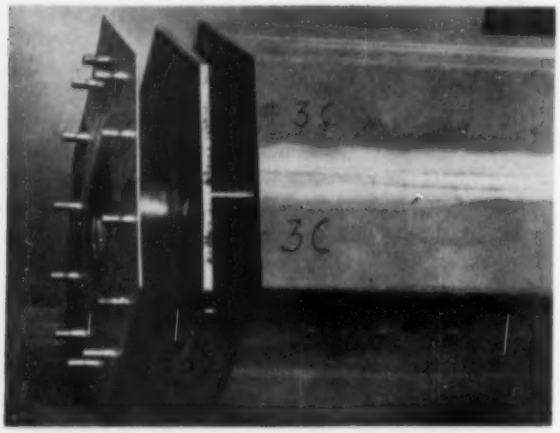


Fig. 11 Top end plate view of first test can assembly

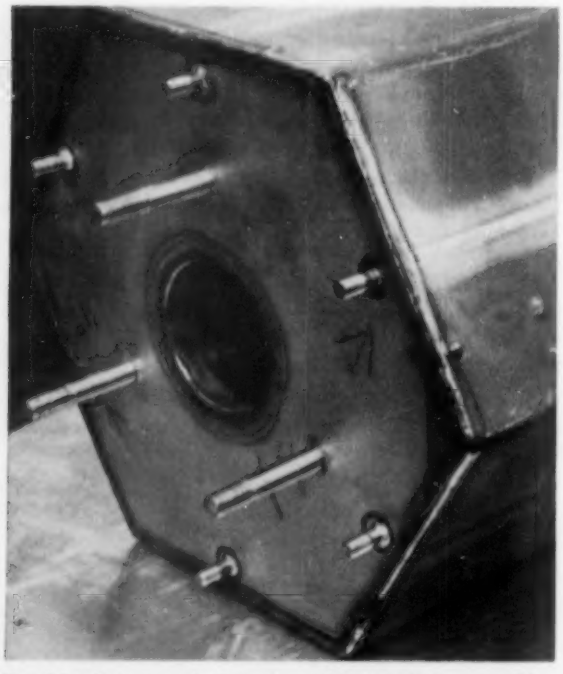


Fig. 12 Bottom end plate view of first test can assembly

Although thorough preweld cleaning will reduce porosity, it will not completely eliminate it.

11. Porosity can be removed from a weld by remelting the nugget a sufficient number of times to allow all of the gases to evolve through the molten puddle. An excessive number of remeltings, however, can result in excessive hardening; but tests on six pass welds indicated they are softer than base metal.

12. Zirconium shows little tendency to shrink when welded.

13. A clearance of $^1/_{16}$ in. between graphite and weld is sufficient to insure against carbon pickup and embrittlement.

14 Neither the hardness nor the minimum bend radius of welds, made with a combination of chill and inert-gas shielding which prevents hardening, can be changed by peening.

After completing Phase 1, specifications outlining requirements for cleaning, welding, inspection and operator certification were written. In spite of the recognized limitations, acceptable and rejectable weld colors were established as indications of the effectiveness of inert-gas shielding. (A surface luster was one color requirement.) Since it was not possible to test production parts for hardness to determine if excessive hardening had occurred, rather rigid manual and automatic operator certification tests were set up. Welds made for these tests were examined visually for color, luster and contour and were tensile, hardness, and minimum bend radius tested. In addition, test welds were inspected by dye penetrant and radiography. Over and above the operator certification requirements, it was required that, before starting any group of automatic welds that necessitated readjustment or resetting the welding variables, a setup certification weld be made and tested. The specifications set radiographic inspection limitations on maximum pore size, not on the basis of mechanical test, but on the basis of an arbitrarily selected maximum tolerable reduction in cross section. The object of limiting the reduction in cross section was to prevent premature leakage caused by corrosion.

Phase 2 of Preproduction Program

In Phase 2 of the preproduction investigation, five full length moderator can shells were welded and inspected to the newly written specifications. In addition, end welds were made on three full-size graphite loaded cans. After completion, these were helium leak checked.

Two short graphite-loaded cans were tensile tested as a check on the weld joint strength data collected in Phase 1. The lead photograph on page 1007 shows a corner weld being made at the fuel channel of one of the short cans. The welder's helper can be seen directing inert gas to the under side of the molten puddle, illustrating the teamwork used between welder and helper to insure adequate inert-gas coverage.

Figure 10 is a photograph, taken while the short cans were being made, illustrating the use of inert backing gas on the welds joining the end plates to the can shells. Gas was passed into the can through the flexible tube

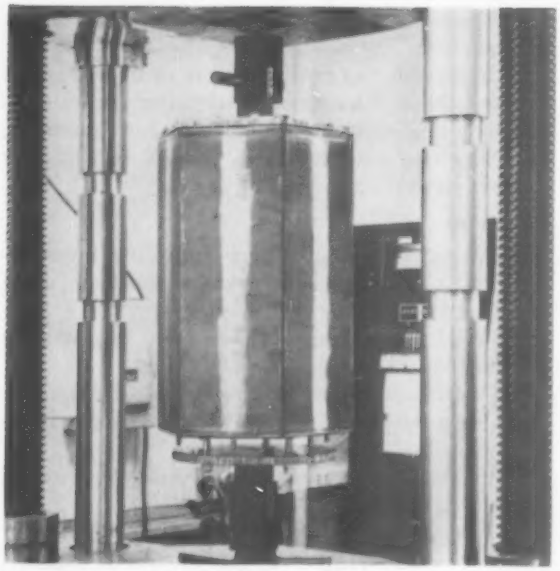


Fig. 13 Tensile testing first test can assembly

shown in the photo. Flow was maintained during welding. After a ten-minute purge, tack welds were made. These were followed by the corner weld around the periphery of the end plate.

Figures 11 and 12 are illustrations showing, from the top and bottom ends respectively, the assembly of one short tensile test can. The load, on this particular can, was applied to the top end plate and the top of the graphite. This was accomplished by securing the tensile test grips to the top end plate studs and to the three protruding bars attached to the hexagonal plate sealed on the inside of the can. Figure 13 is a photograph illustrating the tensile testing of this short can. Loads were applied, in increments, and held while the welds at the top and bottom ends were dye penetrant inspected. After dye penetrant inspection had revealed no cracks at a load of 17 times the design load, the can was removed and helium leak tested. No leaks were detected.

A second short can was tensile tested. In this instance, the loads were applied directly to the studs on the top and bottom end plates as illustrated in Fig. 14. While the loads were increased in increments, a helium leak test was made as shown in Fig. 15. The first leak was detected at a stud loading of 34 times the design load. Failures occurred successively at two additional studs. Figures 16 and 17 are photos showing these failures. It will be noted from Fig. 17 that the failures occurred in the base metal around the periphery of the weld.

Destructive tests were made on the longitudinal welds of development moderator cans. These tests indicated the welds were much harder and much more brittle than the welds made during Phase 1.

Additional tests showed conclusively that this difference in properties was due to a stress relief in air, after forming and before welding. Base metal proper-

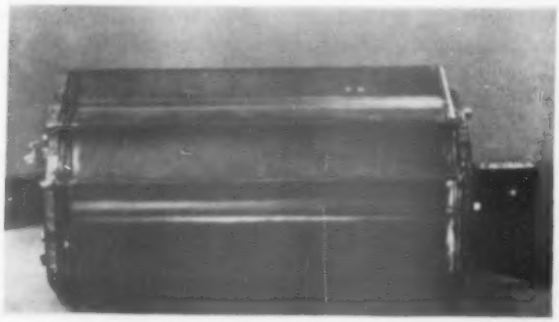


Fig. 14 Second test can assembly

Fig. 15 Leak testing under load

Fig. 16 Failure at 34 times the design load

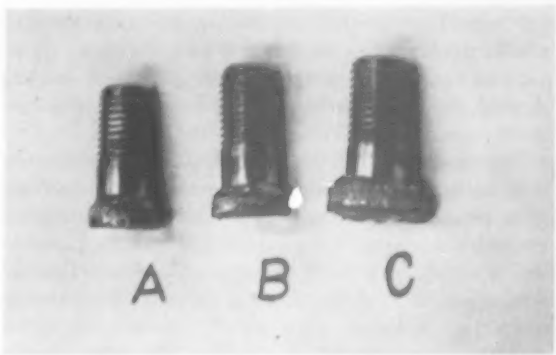


Fig. 17 Closeup of stud failures

ties were completely unaffected by stress relieving, but welds made after stress relieving showed an increase in minimum bend radius of 100 to 200 percent, over welds made during Phase 1. Further work showed that damaging effects of stress relieving could be eliminated by preweld pickling in the proper solution for the proper time.

Production Welds

With the exception of a small percentage of the total work, Phase 2 was completed before production welds were commenced. (The over-all schedule forced a slight overlap.)

After each pass on a production weld, visual, dye penetrant, and radiographic inspections were made. In the first 85 moderator can shells (5100 feet of welding), no welds were rejected for color, contour or cracking. Porosity standards were met in 1 pass on 21 cans, 2 passes on 34 cans, 3 passes on 12 cans, 4 passes on 12 cans, 5 passes on 2 cans, 6 passes on 3 cans and 7 passes on 1 can.

Six hundred feet of butt joint were vacuum annealed prior to welding. A comparison of radiographic inspection records showed that preweld vacuum annealing, to reduce base metal hydrogen content, had little or no effect on weld porosity.

Summary

The three most significant results of this investigation, with a general regard to welding zirconium, could be summed up as follows:

1. Weld bead porosity can be caused by poor joint cleaning, but not poor inert-gas shielding.
2. Welds equal in ductility to the base metal can be made using the proper combination of inert-gas shielding and chill.
3. Color cannot be used as an absolute criterion for judging the soundness of a weld.

DISCUSSION BY D. C. MARTIN

It is interesting to see papers beginning to appear in the unclassified literature on the welding of both zirconium and parts for use in reactors. These will prove of great value to people who are just getting interested in nuclear power. This paper is one which points out some of the problems which will have to be faced, and Mr. Baird is to be congratulated for presenting it.

I would like to comment on one phase of the work which is discussed in the paper. This is the porosity which the author observed in both test and production welds. It has been, in general, the experience of those who have investigated the welding of zirconium and its alloys that a certain amount of porosity could be found in all welds. In some cases, this porosity has caused considerable trouble. Both experimental and production welding results have indicated that porosity is worse in certain lots of zirconium and zirconium alloys. Therefore, there would appear to be some relation between the production history of a particular lot of zirconium and weld porosity. It has been suggested that the quality of the sponge from which the zirconium or zirconium alloy is made is the important factor.

One of the problems with trying to eliminate the porosity in zirconium welds is that there is no good theory to account for its occurrence. It has been suggested that hydrogen may be the cause. However, as Mr. Baird has pointed out, porosity occurs even in welds made in vacuum outgassed zirconium. The correlation that Mr. Baird finds between preweld cleaning and porosity might indicate that hydrogen is the culprit. Other suggested causes for porosity in welds in zirconium have been magnesium chloride left from sponge reduction and inert-shielding-gas occlusion.

I would like to ask Mr. Baird if he has noticed any correlation between incidence of porosity and the lot of material from which the sheet came.

A final comment is that Mr. Baird's remarks on the lack of correlation between weld-surface appearance and weld properties should be remembered. It has been shown quite often that lack of coloring on the surface of a zirconium weld does not mean that the weld properties are acceptable.

D. C. Martin is associated with Battelle Memorial Institute, Columbus, Ohio.

AUTHOR'S REPLY

A very thorough radiographic inspection was made on all the welds on the zirconium moderator cans. A review of the records after the first 5100 ft of welding showed the incidence of porosity was completely random.

Experimental work demonstrated a definite correlation between the incidence of porosity and preweld joint preparation and cleaning. Much effort was expended in insuring that cleaning and welding practices did not vary from joint to joint. Therefore, the random appearance of the porosity must be attributed to some other factor.

Each can contained 60 ft of weld. The entire can was rejected if, after the first pass, the entire 60 ft of weld did not meet the porosity standards of the specification. Often cans were rejected because of a few inches of weld containing excessive porosity. Though only 25% of the first 85 cans met specification requirements after one pass, probably more than 75% of the lineal length of the welds on the 85 cans was acceptable after one pass. Probably more than 95% of the total weld footage was acceptable after the original pass or after the original pass plus one reweld pass.

In attempting to establish a correlation between weld color and weld joint properties, experimental work showed that welds completely free from discoloration are sometimes harder than welds medium or light blue in color.

HEALTH ASPECTS OF WELDING

Adequate personnel protection and sufficient ventilation of work area found to offset any potential health hazards associated with welding processes

BY B. L. VOSBURG AND J. J. FERRY

Editorial Note

The following five papers were presented at the Safety, Health and Fire Prevention session sponsored by the Technical Activities Committee at the 1956 AWS National Spring Meeting:

1. Health Aspects of Welding
2. Safety in Installation and Use of Welding Equipment
3. Fire Prevention in Welding
4. Development of Welding Safe Practices in an Industrial Plant
5. Application of Safe Welding Practices

Because of the close relationship of these papers to one another, it has been found advisable to publish all of them in this one issue.

Fig. 1 Welding a generator spider without ventilation

SYNOPSIS. Articles dealing with potential dangers in various welding operations and with the standards that have been set up to minimize such dangers are reviewed.

The newer types of welding, including the low-hydrogen coating and the inert-gas metal arc, are also discussed in reference to the potential dangers inherent in these processes. A few cases are cited to illustrate the classical respiratory effects when necessary precautions were not followed.

Reference is made to various types of electrodes, including the much disputed thoriated tungsten electrode. Common sense viewpoints are emphasized and an attempt is made to point up the specific dangers and the kinds of protection that are required.

Sir Humphrey Davy[1] in 1810 reported the successful welding together of various metals by means of heat generated with electricity. It was nearly a century later before the idea got a firm foothold in industry, and it required the impact of two world wars to make arc welding the undisputed process for joining metals.

Potential Hazards—Their Early Recognition

During the 1920's and 1930's the application of this newly applied old method spread like wildfire and largely took the place of many slower, more laborious noisier methods. The more efficient process came to be used even for tank, bridge and ship construction, etc. It was during this rapid growth period that the wholesome suspicion about the welding process entailing health hazards became more than suspicion when sporadic illnesses and even deaths were reported by a number of observers. Invariably, one common denominator was found for the death cases. The welding had been done in relatively or severely confined spaces. In these death cases both the oxyacetylene and the electric-arc process were implicated. In 1935 Drinker[2]

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Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7–11.

and others investigated the exact cause of these fatalities. It was found that welding fumes conducted into an animal chamber caused animal death even when the fumes had been filtered. Autopsy of the animals showed that death was due to severe lung irritation and edema. Gas analysis gave high values of nitrogen oxides. It was also demonstrated that animals exposed to high concentrations of iron oxide were unaffected. However, it was later discovered that X-rays of fairly long-service welders commonly showed a seemingly harmless lung deposition of iron oxide that came to be known as welder's siderosis.

During the 1920's it was not uncommon for welders to suffer great inconvenience and discomfort from eye exposure to the welding arc. Gradually, however, when welders and their associates were afforded very adequate eye protection and instructed in its use, the incidence of so-called welders' eye became more and more a rarity.

Early welding had been done with a carbon arc or with bare-steel electrodes. The need for better welds of an increasingly greater variety of metals was met by the introduction of the coated electrode. This process[3] which shields the weld from oxidation had been developed in 1910 but only when a method of extruding the coating onto the rod was perfected in 1927 did it become economically feasible to use it. The extruded coatings[4] contained in varying and secret amounts, besides organic materials such as rags, many easily volatilized metals including manganese, phosphorus, vanadium, chromium and silicates. After much study it was determined that there was essentially no difference in the health hazards involved between bare and covered electrodes because the increased danger of more total fumes from the covered electrode was just about offset by the greater production of potentially dangerous oxides of nitrogen inherent in the bare electrode. Ventilation requirements and other protection remained about the same (see Fig. 1).

Need for Standards

Because of the occasional accidental deaths and because of the newness of the welding art, a great deal of apprehension naturally spread to the Departments of Health and Labor in various states; an apprehension that was shared by many investigators in the field of hygiene and toxicology and by industrial physicians. Soon many of the industrialized states, through committee action, attempted to set up standards for the protection of the health of welders. The New Jersey Code[5] was one of the first to be given widespread publicity in 1940. Shortly after the American Welding Society, in collaboration with the American Standards Association, developed a National Standard[6] that serves as a source of recommended practices pertaining to health and safety in welding.

In 1942, at the request of the National Safety Council, Cranch, with Vosburgh's collaboration, presented a paper[7] at the 31st National Safety Congress at Chicago. Emphasis was given to the real welding hazards, including actinic radiation and air contamination by gases and fumes. What he had to say then is largely true today. The paper described the necessary precautions for eye protection and the need for adequate skin covering. Requirements for ventilation were set on the basis of making certain that the very irritating ozone and nitrogen oxide gases, whose threshold limits had not yet been well established, would be diluted to the point of safety for the welder. Probably the most important contribution of the Cranch and Vosburgh paper was in the emphasis that the very precautions and provisions needed for eliminating genuine hazards would automatically eliminate all of the fanciful or unreal hazards that had come to pervade the anxious minds of many investigators at that time. The authors personally quashed one fanciful rumor that X-rays from the welding arc would produce sterilization in male welders by having some of our welders carry X-ray films in their pants' pockets.

During World War II, Professor Philip Drinker of the Harvard School of Public Health, had responsibility for the health of welders in the shipbuilding industry. By the application of common sense, but more particularly by the application of good local exhaust ventilation, it was discovered that arc welding could be made a safe operation even in the holds of ships.

Low-Hydrogen Method

Chiefly since World War II, many new and unique methods have been perfected for minimizing oxidation in the weld; also for easier welding of steel and nonferrous metals. One of the first of these new methods involved a low-hydrogen coating. This was accomplished by the use of an electrode coating containing fluorides, a material not customarily present in the coatings of mild-steel electrodes.

The fumes produced by electrodes bearing fluorides contain solid particles of fluoride salts, the concentration depending upon the amount and type of fluoride in the flux, the rod size and the amperage used. Under some conditions, gaseous fluorine compounds, probably hydrogen fluoride, may be produced, but normally in extremely small amounts.

Exposure to excessive concentrations of fumes containing fluorides will produce nose and throat irritation, and chronic nosebleed has been reported. Frequently, a tolerance to the irritation may develop, but a cessation of complaints does not necessarily mean that conditions are safe. Absorption of excessive amounts of fluorine compounds through the lungs may produce fluorosis (a change in bone structure) or other systemic effects. The generally accepted maximum allowable concentration[8] of fluorine as fluorides is 2.5 mg per cubic meter of air; for hydrogen fluoride, three parts per million.

The fluxes used in welding stainless steel, nickel and aluminum usually contain fluorides. The same general comments as for low-hydrogen covered electrodes will apply.

Tests have shown that the fumes from stainless-steel electrodes may also contain approximately six

percent of chromates, calculated as CrO_3, apparently produced by oxidation of the chromium. When concentrations of soluble chromates exceed the maximum allowable concentration of 0.1 mg of CrO_3 per cubic meter of air, inhalation of such chromates will produce irritation of the upper respiratory tract.

Submerged-Arc Welding

In submerged-arc welding, the arc is covered with a rather heavy layer of granulated flux which normally shields the arc. These fluxes also contain fluorides. Tests have shown that, when the flux is heated to the melting point, hydrogen fluoride (hydro-fluoric acid) or other gaseous fluorine compounds are produced. The amount of hydrogen fluoride produced depends on the amount of flux heated and the temperature reached. In our experience little difficulty has been noted during machine welding where the size and position of the arc is carefully controlled. There have been complaints of nose and throat irritation during manual welding particularly where large amounts of metal were being deposited.

The Inert-Gas Metal-Arc Process

In the further interest of improving welds and extending the application of welding, the inert-gas metal-arc welding process has been developed. In this process, oxygen is kept away from the welding arc by means of a mantel of inert gas, originally helium or argon, and more recently the less inert carbon dioxide. This process has introduced some very new and unusual potential hazards. The ultraviolet radiation is increased approximately tenfold, depending on the current density, the type of metal being welded and the particular inert gas used. This calls for additional precautions,[9] both in protecting the skin and eyes of the welder and in shielding nearby personnel. Dark—preferably wool—clothing must be worn to cover *all* exposed skin surfaces. Tests by several authorities have shown that adequate eye protection from the ultraviolet is given in the use of the welding lenses that are recommended for the various amperages of ordinary arc welding. The increased brightness from visible light, however, may make it necessary for some people to use lenses that are one or two shades darker in order to prevent eye strain and depletion of the visual purple which is the cause of snow blindness during the summer months in the arctic region. It is worthy of note that intense ultraviolet light may cause the disintegration of cotton clothing. Ozone, which may be hazardous, of course, in any type of welding under conditions of inadequate ventilation, is produced in larger amounts by the inert-gas metal-arc welding process. The amount produced will vary with the type of metal and gas used; also with the current density and the atmospheric humidity. Industrial hygienists have had a bit of a dilemma here because the recently established threshold limit of ozone[10] of 0.1 ppm is quite commonly exceeded. However, even though respiratory irritation has been reported, serious illness has not been encountered, probably due to the fact that the welding arc time is intermittent and usually less than fifty percent of the working day. It has also been shown experimentally[11] that minor lung exposures to ozone afford additional protection against more serious exposures. Obviously this potential hazard must be given due consideration (see Table 1).

Table 1—Ozone and Nitrogen Oxides

Gas used	*Amperage*	*Ozone, ppm*	*Nitrogen oxides, ppm*
Argon	55	0.1	...
Helium	55	0.1	...
Argon	110	0.5	...
Argon	110	0.6*	...
Helium	110	0.1	...
Helium	110	0.1*	...
Helium	110	0.0*	0.3*
Argon	110	0.4	2.5
Argon	110	0.6	3.0*
Helium	110	...	0.5*
Helium	110	...	0.3
Argon	110	...	3.0*
Argon	110	...	2.5

* Normal rate of gas flow was doubled.

Table 2—Phosgene

Gas used	*Trichloro-ethylene, ppm*	*Phosgene produced, ppm*
Argon	0-15	45
Argon	60	140
Argon	100	180
Argon	140	280
Helium	30	6
Helium	30	4

Still another potential hazard in the inert-gas metal-arc welding process relates to the ready conversion of certain chlorinated hydrocarbons to phosgene under the intense actinic radiation (see Table 2). For example, trichloroethylene, commonly used in degreasing operations, may give rise to a dangerous concentration of phosgene[12] even when the concentration of the trichloroethylene vapors is too low to be detected by the sense of smell. Thus degreasing and inert-gas metal-arc welding jobs must be separated physically. It may suffice to accomplish this isolation by ensuring that a positive air current passes from the welding area toward the degreaser.

Because the inert-gas metal-arc welding process produces high temperature, larger amounts of metal fumes may be encountered—again the amount depending chiefly on the current values and the type of metal used. These high concentrations of metal fumes will commonly demand local exhaust ventilation of a type that does not disturb the inert-gas mantel. It is noteworthy that a number of welders have become ill when exposed to copper fumes. The nature of the illness is probably a copper metal fume fever.

While welding nickel using this same process in a poorly ventilated area two welders and their helpers became ill—one welder and one helper seriously ill, with acute pneumonitis.[13] With the installation of enclosed booths, properly exhausted, no further untoward effects were noted (see Figs. 2 and 3).

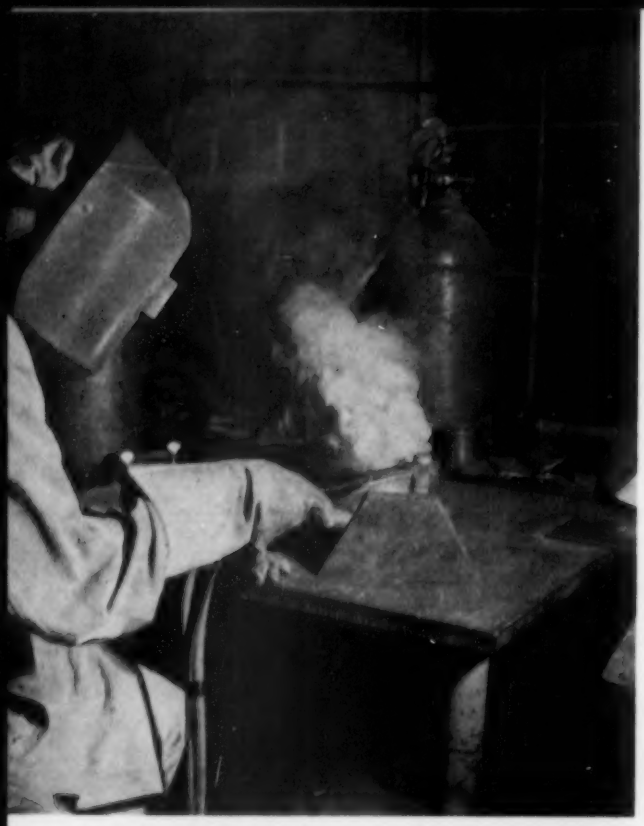

Fig. 2 Inert-gas tungsten-arc welding without ventilation

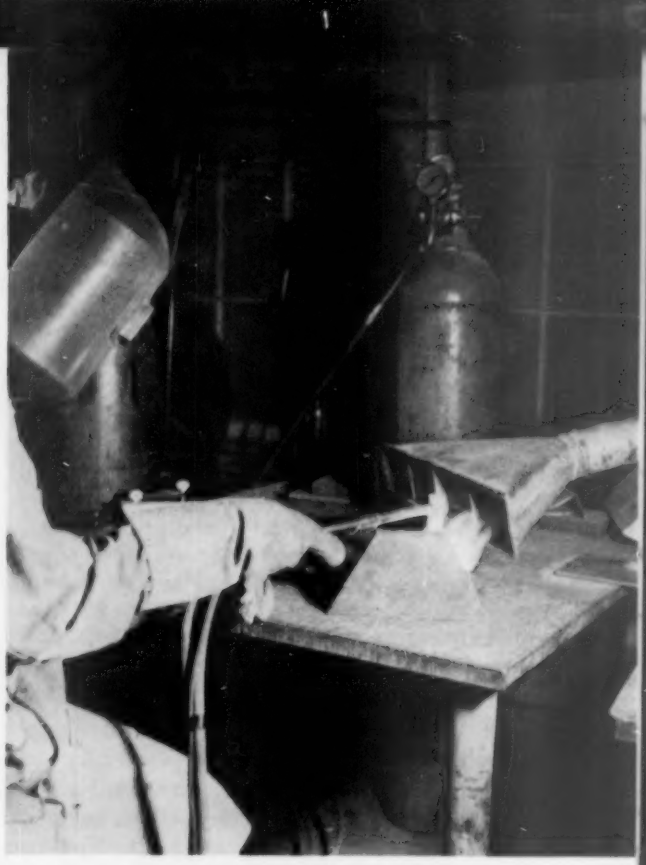

Fig. 3 Inert-gas tungsten-arc welding with ventilation

There has been considerable anxiety, originating with theoretical physicists, in the use of thoriated tungsten electrodes in the inert-gas metal-arc welding process. One company stopped the use and the manufacture of these electrodes for a period because the data set forth by physicists indicated the likelihood that thoria, having low-grade radioactive properties, might present a long term danger. The best published information,[14] however, at this time indicates that there is no hazard from the inhalation of thoria particles except possibly if the welding is done in a confined space. The added precaution should be taken in dressing a thoria-tungsten electrode on a grinding wheel to ensure that it is sufficiently well ventilated to remove all of the dust produced or else keep the tip of the electrode under water during the dressing.

When carbon dioxide is used as a shielding gas, some of it is decomposed by the arc to form carbon monoxide, the amount dependent upon the arc temperature. This potential hazard should also be entertained.

The Atomic-Hydrogen Process

The atomic-hydrogen arc-welding process was developed by Langmuir[15] in 1926. In this process, hydrogen is passed through an arc drawn between two tungsten electrodes. The hydrogen, by disassociation and reassociation, greatly increases the amount of heat available, and also serves to blanket or shield the weld from the air. Filler metal, where needed, is fed into the arc separately. The hazards associated with this process are very similar to those described under Inert-Gas Metal-Arc Welding.

Carbon-Arc Welding

In this old process, a carbon electrode is used with filler metal being added separately if required. When a shield, either gas or flux, is used, the hazards become similar to those under Inert-Gas Metal-Arc Welding.

Arc-Welding Allied Processes

We have devoted considerable time to some of the newer welding methods in order to better pinpoint their inherent potential hazards. A discussion of the health aspects of some of welding's allied processes will help complete the picture.

Cutting. Gas welding and oxygen cutting on mild steel do not generally produce fumes which are harmful under normal conditions. Some oxides of nitrogen may be produced, but these are of no concern except in confined areas.

Powder washing is a form of cutting in which iron powder is fed into the flame. The fumes produced contain, principally, iron oxide and are not considered harmful under normal conditions. However, the amount of fumes and dust produced is usually much greater than in straight cutting, and complaints of a nuisance condition may arise.

Brazing. Fluxes containing fluorides are frequently used in welding and in brazing brass, aluminum or other alloys. In this case the heat of the flame may produce hydrogen fluoride. The concentration of

hydrogen fluoride in the fumes is frequently high enough to be irritating, indicating that it is over the maximum allowable concentration (3 ppm). The concentration produced in the general room air will depend on the room size, general ventilation and the amount of welding or brazing being done. If the flux penetrates the outer skin surface through nicks or cuts, or around the fingernails, it may produce severe irritation. Skin contact should be avoided.

Some brazing alloys may contain cadmium which is readily volatilized on heating. The brown cadmium fumes so evolved are extremely dangerous, producing severe and even fatal lung damage on short exposure. The maximum allowable concentration for cadmium[16] is 0.1 mg. per cubic meter of air.

Extraneous Hazards

In the 1930's Alice Hamilton,[17] in discussing the various illnesses common to the welding trade, admonished:

"If the welder is using his torch on mercury-smeared metal he may get mercurialism; if on a tank that has held grease or oil, acrolein poisoning; if he is welding galvanized (which means zinc-coated) iron, he may have brass founder's ague; if he is helping to scrap battleships by cutting through steel sheets which were painted with red lead, he will surely have lead poisoning; . . . etc."

Welding on materials containing beryllium may produce an extremely dangerous condition. No such welding should be undertaken without proper clearance and then only after complete control of fumes has been provided.

Welding on tanks, pipelines or containers of any sort from which the contents have not been thoroughly removed may introduce a serious hazard by volatization or decomposition of the residue. This is particularly true where chlorinated hydrocarbons or plating solutions may be involved.

Since the possible harmful effects from welding, cutting and brazing operations are closely related to the fumes and gases produced, appropriate consideration must be given the matter of controlling the inhalation of such gases and fumes (see Fig. 4.) For this purpose the AWS-Z49[18] specifications of ventilation are recommended.

Special Respiratory Protection

When standard ventilation requirements cannot be instituted, for some reason, respiratory protective equipment may be required. Air-line respiratory or hose masks will give adequate protection from welding fumes. Air-supplied welding helmets are available commercially but have been used very little in industry because of the annoyance and discomfort involved. Respirators approved for metal fumes will give protection against metal fumes not more toxic than lead provided they are selected, used and maintained properly. Their general use is not recommended, however, because of the difficulty of being sure these provisions are carried out. No cartridge or filter respirator will give protection against oxides of nitrogen; an air-line respirator, hose mask or gas mask is required. Respiratory protective equipment is seldom required at welding operations. In those few instances where it is required, its use should be mandatory.

Fig. 4 A welding shop—general ventilation: metal fume about 1 mg/cu m

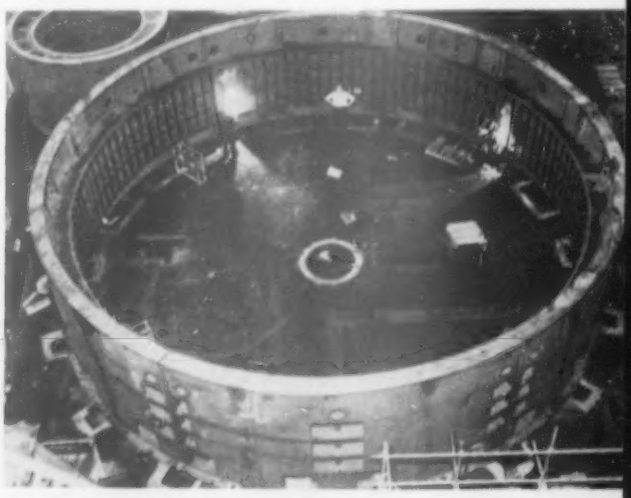

Fig. 5 Welding a large stator frame

Summary of Specific Precautions

The authors would like now to summarize some of the precautions that should be observed:

1. When welding in a confined space, local exhaust ventilation which is adequate to control fumes should be applied. Where any question of adequacy exists, an air-line respirator or hose mask should be worn.

2. When welding indoors on materials containing or coated with toxic substances such as lead, cadmium, etc., local exhaust ventilation should be applied. Air-

line respirators are usually required whether such welding is done indoors or outdoors.

3. Fixed welding locations used for welding on stainless steels, nickel, aluminum or other materials where fluoride fluxes are used should be provided with local exhaust ventilation (see Figs. 5 and 6).

4. Local exhaust ventilation should be provided when nickel or copper is being welded by the inert arc process using the consumable electrode, or by the non-consumable electrode with amperages over 300.

5. All skin surfaces should be covered during inert-arc, carbon-arc or atomic-hydrogen welding.

6. Used tanks or other containers should be thoroughly cleaned before any welding is attempted. The explosion and fire hazard is considered by many to be the worst hazard of all.

A treatise on health in reference to welding would not be complete without brief mention of possible negligence actions. If an employer fails to provide safe working conditions, the injured employee is entitled to workman's compensation under the state's statutes. If the manufacturer of the equipment used can be proved negligent in the design of equipment or in giving adequate warnings, recovery through common law courts may be permissible in some states. For their own protection, therefore, many makers of welding equipment point out the potential dangers and prescribe the safeguards to be taken. This added precaution on the part of manufacturers is apt to have a salutory effect upon the users of welding equipment. To illustrate, one manufacturer has admonished users of inert-gas metal-arc welding equipment with the following operating safety precautions:

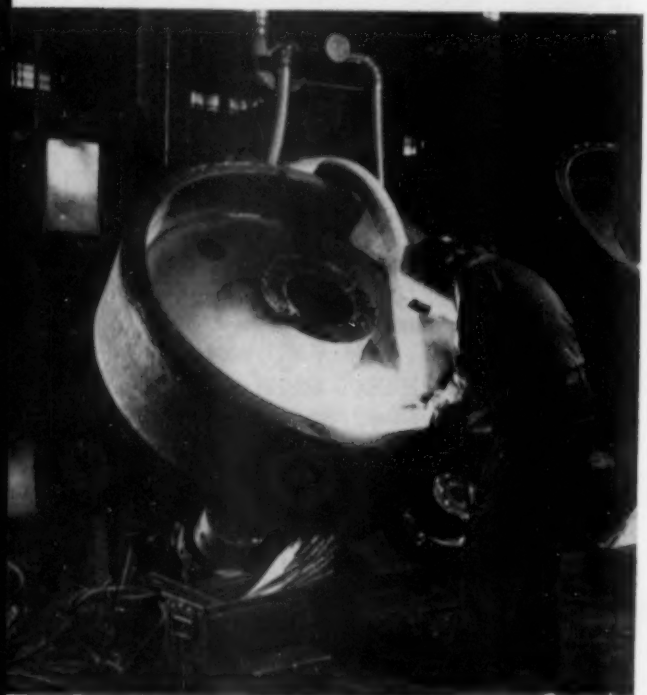

Fig. 6 Welding a generator spider using local exhaust ventilation

1. Provide adequate ventilation.
2. Beware of degreasers.
3. Eye protection.
4. Protect the skin—operator should be protected.

Health Maintenance Program

Some employers have instituted health maintenance programs for welders. That preventive medical service usually consists of a good physical examination supplemented by a urinalysis, tests of vision and hearing and a chest X-ray. The examination is conducted about once a year and serves to spot siderosis or other lung pathology and any change in vision or hearing. The importance of good vision can be readily appreciated since it has a direct bearing on quality of work and the welder's ability to keep his helmet away from maximum fume and gas production. The examination may also demonstrate management's interest in the health of employees.

Like many other potentially hazardous processes, welding, in its many and varied applications, requires the cooperation of all the people involved in order to accomplish an optimum health status for the trade. Those who design and build and install the equipment have a big responsibility for the welder's health and so do the safety supervisor, the ventilating engineer and the industrial hygienist. But the welder himself must also share in good measure the safeguarding of his own health. An important part in learning his trade is the acquisition of a wholesome respect for the potential hazards involved. Unless a welder understands exactly why each and every safeguard has been afforded him, he is not apt to take his own protection seriously. Unless he really appreciates that the gases and fumes may be harmful, he will fail to develop the good habit of viewing his work from the side and away from maximum gas and fume production.

Adequate time spent in orienting and teaching the man who does the work will surely prove a good long term investment.

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14. Breslin and Harris, *Am. Ind. Hygiene Assn. Quart.*, 13, 4, 191 (December 1952).
15. Wishart, Ronald, "The Arc Triumphs," *R.P.I. Engr.*, III, No. 4 January 1950).
16. Ferry, J. J., and Ginther, G. B., Gases Produced by Inert Arc Welding, reprinted from *Am. Ind. Hygiene Assn. Quart.*, **13**, 4 (December 1952).
17. Hamilton, Alice, "Health Hazards in Welding," p. 3, Preliminary Report: Health Hazards in Welding Operations, New Jersey Industrial Safety Committee, February 1940.
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SAFETY IN INSTALLATION AND USE OF WELDING EQUIPMENT

This presentation covers daily safety requirements and practices which are either ignored by operating personnel or overlooked by supervisors

BY BENJAMIN F. POSTMAN

Introduction

One of the major fire insurance organizations recently reported that during 1955, there were a considerable number of fires in their insureds' plants, involving cutting and welding operations. This is only one facet of the problem of exposure to welding and cutting activities. The other items are: serious explosions involving personnel and/or plants and their physical inventory, burns and the potentiality of electrocution where electric arc welding is involved.

Management, particularly shop superintendents and shop foremen, should read and become acquainted with the detailed data as outlined in the following bulletins:

1. Safe Practices for Welding & Cutting Containers That Have Held Combustibles.
2. Recommended Safe Practices for Inert-Gas Metal-Arc Welding (A tentative publication).
3. Safety in Electric & Gas Welding & Cutting Operations—American Standard Z49.1

These bulletins are available from the AMERICAN WELDING SOCIETY.

Specific details for the design, erection and installation of acetylene generator buildings, distributive piping systems or manifolding of oxygen and acetylene cylinders are beyond the scope of this paper. However, stress will be placed on the most obvious, but least suspected operating conditions which do cause injury, death, and unwarranted replacement cost where buildings and/or contents are involved.

Gas Welding and Cutting Operations

The location of an acetylene generator building should be carefully checked and approved by the Fire Underwriters insuring the plant. In addition, there must be full compliance with local regulations, which in many instances, are completely overlooked or ignored. One should never lose sight of the fact that mixtures of flammable acetylene gas and air are extremely explosive. Gas leaks, smoking in the area or adjacent sources of possible ignition should always be guarded against.

To what extent are operating personnel properly instructed relative to the inherent hazards involved? How often is operator technique checked by supervisors or safety engineers? Operators readily develop malpractices, and these, coupled with the labor turnover experienced in many of our industrial installations, call for more serious attention by management.

As for oxygen and fuel gas cylinders, it has been found desirable to store full cylinders outdoors or on loading platforms, protected against the weather, or indoors if space permits. Separate areas for full and empty cylinders, chained or separated by structural steel members, should be mandatory along with oxygen cylinders being stored in separate areas and away from acetylene cylinders, and large wall signs designating the use to which the separate areas have been allocated.

So-called "empty" cylinders are never completely empty and where oxygen cylinders are concerned, there is potential danger.

The most prolific and usual abuses of protection involving cylinders, particularly full cylinders, are:

1. Protective caps not tightly secured in place.
2. Connection of gas cylinders to equipment by means of rubber hose without any provision for preventing the cylinder(s) from falling on employees' feet, adjacent equipment or as a result of a fall, destroying valuable glass equipment, particularly in research laboratories where expensive and extensive experiments are in progress.
3. The oxygen in a full cylinder is under a pressure of approximately 2200 psi. Disastrous experience has demonstrated that a fallen cylinder with an unprotected valve which may be snapped off as a result of the fall, can take off like a jet-propelled bomb, penetrate brick and concrete walls, destroy property and

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Presented at the 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7-11.

kill people. The following is quoted from the March 19, 1956 issue of *Fire Safety Newsletter* published by the Mutual Fire Insurance Companies: "The University of Maryland's fire newsletter mentions a case where compressed gas cylinders were being unloaded from a truck. Some didn't have protective caps. One fell to the ground, sheared off the valve from the cylinder's head, releasing the gaseous contents. The cylinder became a jet-propelled projectile, rose 12 feet, went through a window, leveled a pile of drums inside, missed some workmen and ricocheted into two work benches inside the plant."

4. The in-plant transfer of cylinders on a hand truck unchained and without valve caps in place.

We frequently observe cylinders transported in this manner from one job to another. Where are the standard carriers? Where is the supervision?

5. Empty cylinders should *never* be permitted to be used as rollers under equipment. We recently saw some empty oxygen cylinders used for this purpose in a machine shop to transfer castings from one metal-working machine to another.

Arc Welding and Cutting Operations

Some of the major items of exposure to be considered under this category are:

1. Shock and/or electrocution involving improper or lack of grounding, frayed cables and water puddles.

2. Possibility of explosion or ignition of adjacent flammable vapors.

3. Potentiality of serious health exposures with possible fatal sequelae, involving the decomposition of carbontetrachloride, trichlorethylene, and perchlorethylene. One of the dissociation products from any of these materials is phosgene, a poisonous gas. In a confined area, trouble should be anticipated.

4. Eye injury to helpers, foremen or other personnel who may be in the welding area.

5. Fires resulting from the use of:

A. Combustible tarpaulins. There is *no* legitimate reason for this, since impregnated fire-resistive tarpaulins are available. This potential exposure may be *completely* eliminated by the use of portable or fixed shields or partitions made of metal or noncombustible material.

B. Absence of fire watchers during welding repairs.

C. Improper and/or inadequate fire protection devices.

D. Repairs adjacent to or in areas where combustible or flammable stock is stored or used.

6. Electric burns.

7. Burns from flying sparks, particularly from spot welding units. Section 5.25 of American Standard Z49.1 reads as follows: "The hazard of flying sparks *shall* be eliminated by installing a shield guard of safety glass or cellulose acetate at points of operation. Additional shields or curtains *shall* be installed as necessary to protect passing persons from flying sparks." It would be interesting to poll those who may have spot welders in their production set-up, to determine the extent of acquiescence to this pertinent and important paragraph.

In connection with burns, as far as male employees are concerned, they usually occur on hands and arms, if unprotected by gloves and sleeves. Female workers have an additional exposure due to the V-neck condition of their blouses, an enticing beauty adjunct which may become a serious safety problem. Both male and female employees with long hair should be provided with and required to wear protective caps.

8. Welding or cutting containers which may have held flammable solvents.

Special precautions are outlined in bulletin A6.0–52, *Welding and Cutting Containers That Have Held Combustibles.* In connection with this item, but applicable to gas-welding operators, a welder was killed in one of our plants some years ago under the following conditions: When the noon whistle blew, the welder climbed out of a manifold opening in a tank body he was welding to be used for gasoline or oil transportation. He removed his gloves and helmet and hung the torch over the *inside* of the manifold opening. After lunch, he entered the tank and struck a spark to light his torch. There was a terrific explosion which catapulted the welder into the air. He died a few hours later. The only explanation we could advance was a leaky hose connection at the torch. The specific malpractice involved was hanging the torch on the inside of the manifold opening.

Would safe supervision have required the use of an air blower to purge the tank previous to re-entry and possible use of an explosion meter? Modern production demands do not permit such "valuable time to be lost on unnecessary, foolish, theoretical and impracticable suggestions."

Ventilation

Ventilation is a debatable question among welders including *both* management and personnel. In spite of this attitude, the Z49.1 committee has spent considerable time and energy over the years, discussing and promulgating practical ventilation requirements for all types of welding operations. These data are tabulated in American Standard Z49.1. The application of some of these data to welding operations is described later in this paper.

Wherever potentially toxic materials are welded or are used in welding operations, local exhaust should be mandatory. Such items as lead, cadmium, mercury involving antifouling paint on ship bottoms, zinc, flouride-bearing flux, stainless steel, etc., have been covered in the above mentioned standard.

The latest interest is in the use of flux containing hydrazine salts for soft soldering operations. This material has been used industrially for approximately seven years and has been available to all since December 1955. The manufacturer of this material states that there is no free bromine or hydrazine released as a result of the soldering operations. Nevertheless, ventilation is recommended for the use of this material.

Medical Control

Medical control is recommended in American Standard Z49.1 and covers a preplacement physical and chest X-ray examination.

Last year we were confronted with a silicosis claim involving a welder employed in the manufacture of steel tanks for gasoline and oil truck use. The chest X-ray did indicate a diffused and distorted picture, which under normal conditions of operator exposure in that type of work, could indicate a chest condition characterized as siderosis. This covers the deposition of fine iron oxide particles on the lung tissues, volatilized by a welding torch or arc, released from the welding rod or items being welded or cut.

An inspection of the plant areas, materials used in the welding rods and a survey of the past occupational history which was available, did not reveal any exposure or condition which could cause silicosis, a disease which is characterized as the fibrosis of lung tissue resulting from long exposure to high concentrations, of a high percentage of free silica, the causative agent in the development of silicosis.

This claimant died. A postmortem was performed and the medical diagnosis was lung cancer.

In some states, exposure to dust and fumes, which in themselves are not considered toxic but only nuisance items, might be considered as aggravating a known or unknown pre-existing condition, which may result in a costly compensation claim.

Weld Examination

Though not mentioned in American Standard Z49.1, under some conditions, welders in some shops may be exposed to a serious health hazard involving the use of X-ray, radium and radioactive isotopes such as cobalt 60, iridium 192 and cesium 137, utilized for the inspection of welds, in accordance with some specification requirements.

The welders themselves are not handling any of these potent and dangerous materials, but may be exposed to stray radiation where weld examination is performed in open shop areas, not completely shielded against leaks of stray emanations of the beta or gamma rays.

There are several methods of control:

1. Periodic check with proper instruments which are available, to evaluate the presence or absence of stray radiation. Such data should be recorded on a checking form for future reference.

The Industrial Hygiene Division in most State Health or Labor Departments would be available for such short period notice when tests are to be made. This service is free and should be utilized by industry.

2. Weld examination of longitudinal or girth seams of tanks or similar units by means of a stationary X-ray unit located under the carriage supporting such units, or the use of portable X-ray equipment or units now utilizing radioactive isotopes, should, if at *all* possible, be performed at night. This will then only involve the X-ray technicians who are usually properly indoctrinated and protected by the use of pocket dosimeters and/or film badges.

3. In the final analysis, distance is the safest control available. If items 1 and 2 noted above cannot be performed as indicated, then welders in areas adjacent to the test areas should be removed during the short period required for the examination of the item being checked.

At this point, it may be of interest to see the results of an unscheduled and, certainly, an unforseen explosion.

Fig. 1 Electric welding repair of stainless steel baskets. Note fume dispersion to the general work area when controls are off

Fig. 2 Electric welding repair of stainless steel baskets. Note effectiveness of applied control in preventing fume dispersion to the general work area

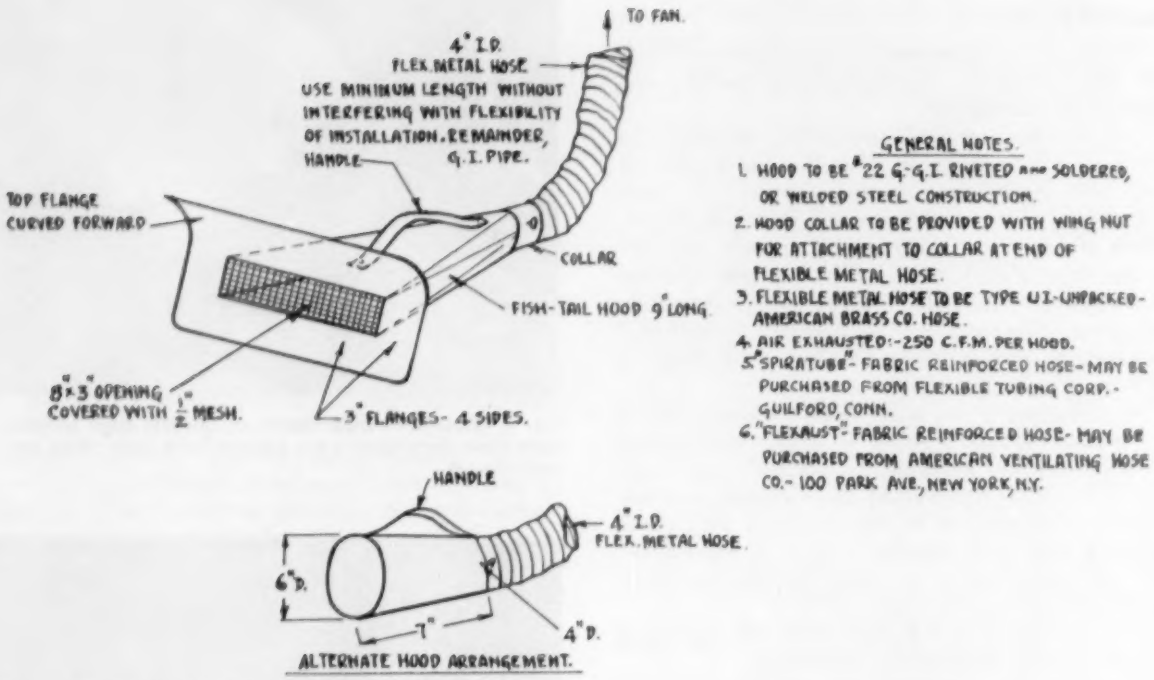
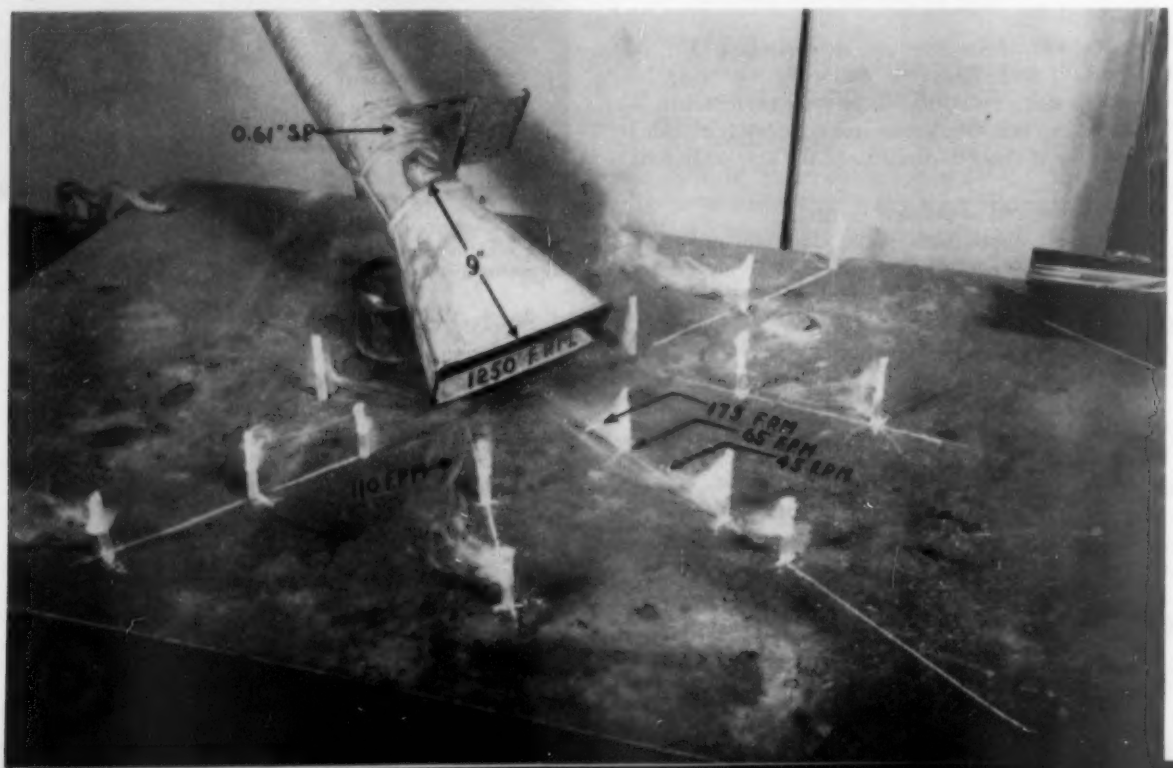

TO FAN.
4" I.D.
FLEX. METAL HOSE
USE MINIMUM LENGTH WITHOUT INTERFERING WITH FLEXIBILITY OF INSTALLATION. REMAINDER, G.I. PIPE.
HANDLE
TOP FLANGE CURVED FORWARD
COLLAR
FISH-TAIL HOOD 9" LONG.
8"×3" OPENING COVERED WITH 1/2" MESH.
3" FLANGES- 4 SIDES.
GENERAL NOTES.
1. HOOD TO BE #22 G.-G.I. RIVETED AND SOLDERED, OR WELDED STEEL CONSTRUCTION.
2. HOOD COLLAR TO BE PROVIDED WITH WING NUT FOR ATTACHMENT TO COLLAR AT END OF FLEXIBLE METAL HOSE.
3. FLEXIBLE METAL HOSE TO BE TYPE U.I.-UNPACKED- AMERICAN BRASS CO. HOSE.
4. AIR EXHAUSTED:- 250 C.F.M. PER HOOD.
5. "SPIRATUBE"- FABRIC REINFORCED HOSE- MAY BE PURCHASED FROM FLEXIBLE TUBING CORP.- GUILFORD, CONN.
6. "FLEXAUST"- FABRIC REINFORCED HOSE- MAY BE PURCHASED FROM AMERICAN VENTILATING HOSE CO.- 100 PARK AVE., NEW YORK, N.Y.
HANDLE
4" I.D.
FLEX. METAL HOSE.
6" D.
7"
4" D.
ALTERNATE HOOD ARRANGEMENT.

Fig. 3 Proposed exhaust for electric welding operation

A few broken pieces are all that remains of a pressure regulator which was connected to an oxyacetylene welding unit in one of our plants. The welder, a man over 70 years of age, used this equipment all morning without any sign of trouble. About 12:50 P.M. when he finished his lunch, he started to open the valve on this regulator when a terrific blast of flame shot out from the regulator housing. The fact that the operator's right hand partially covered the valve housing, since the regulating spindle was in the palm of his hand,

Fig. 4 Air flow test of fish-tail type exhaust hood without flanges



saved his eyes. The flame projected itself along the underside of his forearm and upper arm and his skin was severely burnt. He was taken to the plant Dispensary and then to a hospital, where he soon recovered.

A thorough investigation of this accident, which could have ended as a fatality, produced no evidence of its cause. The following are some pertinent facts:

1. A *pressure regulator* had recently been sent out to be repaired. The unit had been sent to the supplier of welding supplies, but whether this supplier repaired the regulator himself or sent it to the manufacturer could not be ascertained, since there was no serial number on this regulator. Therefore *we* could not ascertain if this was the repaired regulator.

2. The Maintenance Dept. of the plant, knowing the potentiality of oil and grease and oxygen as a mixture, certainly did not use any grease on the threads of the regulator during the assembly to the tanks.

3. If the regulator had been checked for accuracy on a standard gage tester, was there a possibility that some of the fluid medium, used in the test, had accidentally seeped thru the system and lodged in the interior of the regulator housing?

4. Why didn't the explosion result during the four or five hours of operation in the morning?

It would be most interesting if the actual causes of this exposition could be ascertained.

Typical Cases

Figures 1 and 2 illustrate a nonexhausted and exhausted condition involving heavy gage stainless steel mesh baskets. The results of the application of local exhaust close to the source of fume dispersion is obvious. Two exhaust hoods are used on this job. This was one of sixteen stations connected to the central exhaust system—an army installation.

Figure 3 illustrates two types of hood. The sketch is usually transmitted to our insureds to present the details of the exhaust hoods to be used on a proposed installation, which may be either bench or floor operations. The flanged hood may be modified by the addition of adjustable rod or feet units, held in place by wing nuts and a small slide holder welded to the rear of the flange at each side of the hood opening.

In connection with this type of exhaust equipment there are several manufacturers who sell commercial units for the control of welding fumes.

The increased effectiveness of the use of flanges about exhaust hoods is illustrated in Figs. 4 and 5. These illustrations indicate the increased air velocity at critical points where eddy currents usually disturb the air flow pattern into an exhaust opening. As an example, if air is exhausted by means of an open-ended pipe or duct, irrespective of diameter D, the velocity of the air being exhausted, measured along the extended centerline of the duct opening at a position one diameter or D distance from the open end, will be approximately only one-tenth the velocity of the air at the face of the open pipe or duct.

Conclusion

This presentation has been keyed to one major thought—properly supervised electric and gas welding and cutting operations, can and *should* be performed safely without injury to personnel or unnecessary destruction of plant or equipment.

Fig. 5 Air flow test of fish-tail type exhaust hood complete with flanges on all four sides of inlet

FIRE PROTECTION IN WELDING

Sound thinking and careful planning in advance of each welding and cutting operation is urged to eliminate possible fire losses

BY EARL R. WALLACE

Introduction

A review of the records of fire losses during recent years gives us many examples of inadequate training, poor planning, and evident lack of interest on the part of maintenance personnel and plant management which have resulted in unnecessary losses in property. A few extreme cases, so selected for the purpose of emphasis, will be cited herein.

Some Extreme Cases on Record

In Minnesota a warehouse burned with a two-million dollar loss. The fire outbreak was caused from welding sparks in an area where sprinklers had been shut off for repair and alteration. In another case at two o'clock in the morning, a fire started in a dip tank from a spark in nearby welding operations. Employees nearby ignored hand protection. Again, in another plant, sparks from a welding operation dropped through a small hole in the floor to the basement where they ignited oily rags and paper, which in turn ignited oil-soaked wooden racks. Heavy smoke prohibited close range fire fighting and the fire intensity was sufficient to cause floor sagging allowing tools and equipment to drop through and cause complete ruin.

A maintenance man in yet another shop attempted to cut off the lead connection from a benzene condenser coil with an acetylene flame. As he did so, benzene spilled from the condenser and burst into flames. In this case, the fire was held in check by six hose lines wetting down the adjacent area.

In another case, we find where sparks from a welding operation ignited waterproof paper and burlap wrappings on coils of steel. The fire flashed upward over the pile and fused one sprinkler head. While the sprinkler controlled the fire, the resultant water damage caused severe loss to the tempered strip stock.

In another case, in a large construction shed, a forge was located adjacent to a welding shop. About midnight the watchman saw the shed burst into flames. The cause was determined as leaking acetylene drifting to the coals in the forge. The acetylene leak was the result of inadequately closed valves.

These examples give indication that a considerable problem is in existence in maintenance work in industry where oxyacetylene flames are used. From information taken from the losses by one insurance company the average loss from fires caused by open flames and torches is approximately $20,000 per month. Much of this loss could be prevented by a careful study of maintenance problems and techniques within the plant. It is becoming evident in many industries that the use of welding and cutting procedures saves a tremendous amount of money in terms of labor and material. We wonder sometimes if we are not leaving the era of the journeyman mechanic and entering the age of all welded construction.

In another case it was necessary to make some modifications to a conveyor mono-rail over varnish dip tanks. The maintenance personnel spread canvas tarpaulins over the open dip tanks. Shortly thereafter the welder started welding and one of the tanks burst into flames. Hand carbon dioxide units were put into operation but the fire spread to an exhaust duct. While the fire was soon brought under control by the plant fire brigade, certain lessons were learned as follows: First, the dip tanks had been equipped with self-closing covers equipped with fusible links—the links had been removed. Secondly, the tanks had been provided with special foam protection which had been removed by the maintenance crew because it was in the way of the construction. Third, the tarpaulins used by the maintenance personnel had not been flame-proofed. We wonder why the tank covers were not closed; we wonder why supervision had not drained the lacquer tanks; we wonder why the tarpaulins were not flame-proofed.

In another location a great deal more interest had been taken in the safety of property and lives by the maintenance crew. Door stops were being installed on loading docks for the outside doors. Supervisory instructions required the use of drills inside the building but permitted the use of a cutting torch on the outside. A fire watcher had been provided to extinguish

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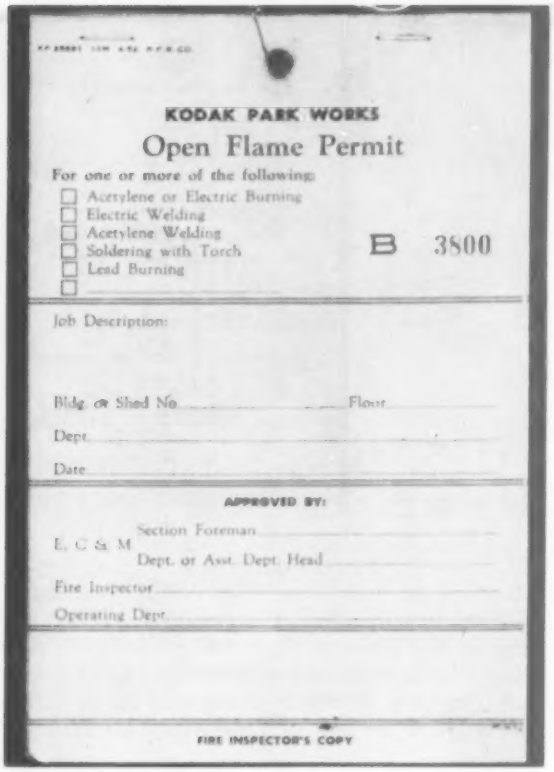
Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7-11.



KODAK PARK WORKS

Open Flame Permit

For one or more of the following:

- ☐ Acetylene or Electric Burning
- ☐ Electric Welding
- ☐ Acetylene Welding
- ☐ Soldering with Torch
- ☐ Lead Burning
- ☐ _____

B 3800

Job Description:

Bldg. or Shed No. _____ Floor _____

Dept. _____

Date _____

APPROVED BY:

E. C. & M. Section Foreman _____

Dept. or Asst. Dept. Head _____

Fire Inspector _____

Operating Dept. _____

FIRE INSPECTOR'S COPY

Fig. 1 Typical open flame permit

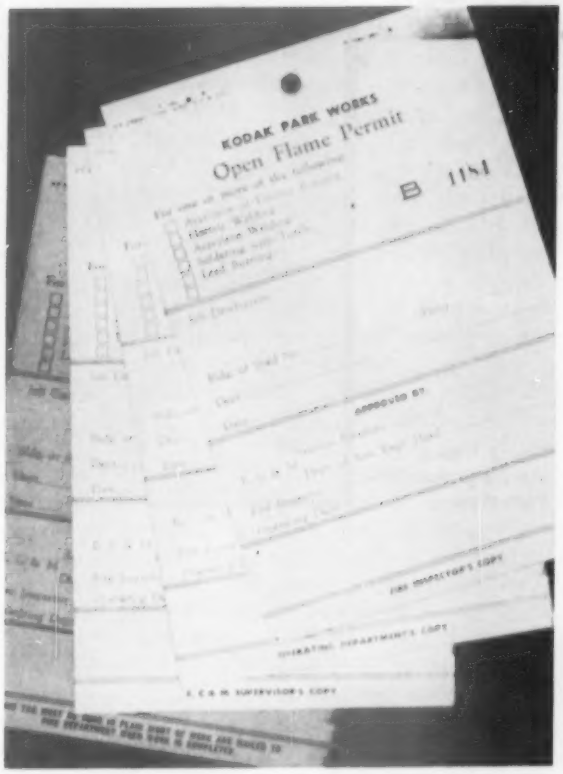


Fig. 2 Four copies, four colors

any fire in grass or weeds but no provision had been made to keep sparks from rolling under the doors. Some sparks did roll beneath the door and ignited packing materials used in wrapping finished products. In this case the insurance people had recommended sprinkler protection for the loading dock. However, the protection had not been provided by management and as a result of this another severe major industrial loss existed. And, of course, we are all aware or familiar with the multimillion dollar loss at Livonia. The details of this accident will not be reviewed here since, no doubt, they have been widely publicized. However, the author would like briefly to comment on the multimillion dollar loss his company experienced a few years ago as a result of familiarity breeding contempt for what was considered well-established rules.

In a paper storage building, modifications were being made to the air ventilation duct system. The area was partially sprinklered in those sections considered high hazard. The balance of the area was unsprinklered as tests had indicated the material, heavy paper rolls, was extremely difficult to ignite. Shortly before noon on a Saturday, a welding crew started to work on the removal of some rods inside the duct work. This welding crew had a welding permit which had been okayed for another area in the building and, because the mechanics assigned to the duct change operation felt that some time could be saved, they talked the welders into doing the removal work for them. The welder cut one of the bars. No one saw fit to check beneath the welding operation. The job was completed and the entire crew went to lunch.

Directly beneath the area on which the welder had worked, there was a filter bag room and a chunk of molten metal dropped to the floor and bounced into one of the duct collars where it smoldered for considerable length of time. Suddenly there was a smoke explosion followed by a series of dust explosions throughout the entire duct system, starting fires in the paper stock room in every location. Several days later when the fire was extinguished, damages were estimated to be in the millions.

How can we prevent such occurrences? First, we must have management's interest and knowledge of the hazards; second, we must have our welders trained in the proper use of preventative techniques; third, our supervision must have an understanding of the probabilities in any welding operation; and, last, we must have a control system so designed that responsibilities are indicated in advance, that each man knows his function in every welding operation, regardless of location. This can be accomplished best by use of an "Open Flame Permit."

Open Flame Permit

We call it the "Open Flame Permit"—a permit designed to serve a multiple purpose. First, it advises the maintenance supervisor that welding is necessary.

IN CASE OF FIRE TURN IN BOX ALARM

FIRE PROTECTION CHECK LIST

1. All debris and combustible materials shall be removed from the area before starting work.
2. Area shall be inspected after completion of work.

SPECIAL INSTRUCTIONS

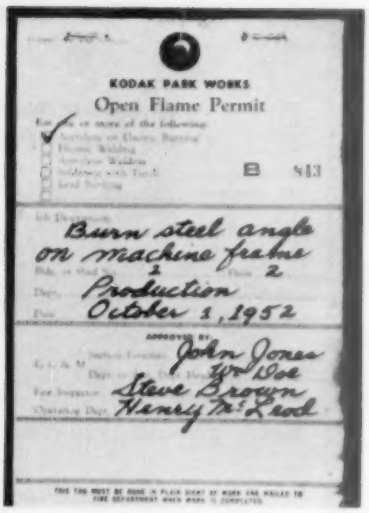
3. A man with an extinguisher shall remain on job ____ minutes after work is complete.
4. Area shall be wet down before and after operations.
5. Helper or other person shall act as fire guard.
6.

I fully understand the requirements and accept the responsibility to carry them out.

Mechanic

FIRE DEPARTMENT - DIAL 444

Fig. 3 Back of last copy: special instructions



KODAK PARK WORKS

Open Flame Permit

For 1 or more of the following:

✓ Acetylene or Electric Burning

Electric Welding

Acetylene Welding

Soldering with Torch

Lead Burning

B 813

Job Description

Burn steel angle on machine frame

Bldg. or Shop 1 Floor 2

Dept. Production

Date October 1, 1952

APPROVED BY

Supervisor John Jones

Fire Inspector Wm Doe

Operating Dept. Steve Brown

Maintenance Dept. Henry M. Lead

THIS TAG MUST BE HUNG IN PLACE EVERY AT WORK AND MAILED TO FIRE DEPARTMENT WHEN WORK IS COMPLETED

Fig. 4 Properly filled out permit

Second, it indicates to the departmental supervision that welding is to be done. Third, it notifies the fire inspector of Safety Department that a request is being made for open flame use.

Figure 1 shows the open flame permit used in our plant. The permit is numbered so that records may be kept by that number of the locations where permits have been issued. This permit is made in four parts with carbon inter-leaving so that the information on the first copy will be transferred to all copies.

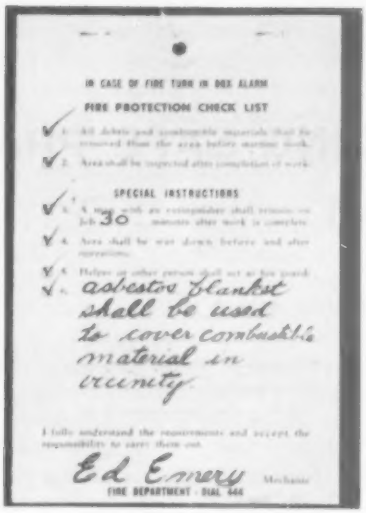
In Figure 2, the copies are of different colors. Each copy goes to a different location. In other words, each person signing the permit retains a copy of the permit for his own records and information. The reverse side of the last copy of the permit (Figure 3) has printed information on it dealing with special instructions for the welder by men of that department a little later.

Figure 4 shows a permit filled out for a hypothetical case. We have assumed that welding is necessary on a maintenance operation on a production machine where the maintenance supervisor feels it is necessary to use oxygen cutting to remove a steel angle on the machine frame. The first step in filling out an open flame permit is this: The mechanic or the maintenance foreman checks the type of open flame requested. In this case, he has checked the No. 1 block indicating oxyacetylene. Secondly, under "Job Description" he briefly outlines what is to be done. Beneath that, he gives the building number, the floor number, the department name and the date. He is then ready to obtain his approvals. First, the section foreman must sign; next, the maintenance supervisor must sign; then either the safety or fire inspector—after checking the location for hazards and setting up the special instructions which will be listed on the back—will sign. And, last, it is necessary to have the signature of an authorized representative of the production department. Most frequently, in actual practice all the signatures are obtained on the job where the work is to be done. In obtaining the signature in this fashion, everyone should be in agreement as to precautions to be taken. After the maintenance department, fire inspector and operating department have received their copies of the permit, the last copy, or red tag, is hung conspicuously on the welding equipment so that any welding to be done without such a tag can be spotted quickly.

Figure 5 shows the reverse side of the welding permit. Here we show the fire protection check list. Item 1 indicates that all debris and combustible material shall be removed from the area. Second requirement is to inspect the area after completion of work. Under "Special Instructions" the fire inspector indicates the number of minutes after work is completed to check or recheck the area. The instructions also include the statement that the mechanic's helper or other person appointed shall act as a fire guard while the open flame is in operation. This individual should be equipped with either a running water hose or a pump-type water fire extinguisher. And, in the last block, special instructions indicate, in our hypothetical case, the use of an asbestos blanket to cover combustible materials in the vicinity of the job. It will be noted that the mechanic has signed the back of the permit after checking all the items listed. He signs this in the presence of his supervisor and the fire inspector.

Conditions for Effective Use of Open Flame Permit

Before such a permit can be used effectively in industry, there are many things to take into consideration. First, the Safety Department or other agency should set up those locations where welding should not be permitted. Those areas should be located on a map or in some other easily understood manner so that all members of the maintenance supervision staff would be aware of the forbidden areas. Secondly, areas of lesser hazard where open flames may be used



IN CASE OF FIRE TURN IN BOX ALARM

FIRE PROTECTION CHECK LIST

SPECIAL INSTRUCTIONS

30

asbestos blanket shall be used to cover combustible material in vicinity

Ed Emery

FIRE DEPARTMENT - DIAL 646

Fig. 5 Properly filled out instructions

with special controls, or, we might say, with restrictions, should also be indicated. Third, on the map there should be indicated those areas where permanent open flame permits should be issued. An example of such locations is the boiler room in a coal fire steam plant.

Next, top supervision should designate authorized personnel and list the names of those persons on a letter to the maintenance department and fire inspection department of those persons authorized to sign open flame permits.

Third, the fire inspection personnel should be carefully trained in the hazards of open flames and the fundamentals of fire protection and should be taught the values of close adherence to an established practice.

Fourth, the maintenance crews using welding or oxygen cutting equipment should receive a thorough course in the proper use and maintenance of the equipment and should be given instructions in the hazards of cutting and welding apparatus. The maintenance crew should also be trained in the fundamentals of first aid fire fighting. They should know how to turn in a fire alarm and they should be made aware of their responsibility to the industry itself. After this has been put into effect and the open flame permit devised, each job application should be made well enough in advance so that the fire inspector, together with the welding foreman and a representative of the operating department, can make a thorough survey of the area where the welding is to be done and set up the specific job instructions for that operation. It should be their responsibility to determine the changes which may be necessary in relocations of supplies or materials in order to complete the job. It shall be their responsibility to see that the welder is equipped with first aid fire protection and knows how to use it, and that the extinguisher is full and in good working order. It is their responsibility to see that adequate fire watchers are placed on the job for the duration and for a sufficient time after the job is completed to be sure that fires are not going to occur after completion. It shall be their responsibility to appoint a fire guard who will be responsible for maintaining compliance with the rules set up by the group during the course of the work. When these things have been completed the job description should be placed on the permit with the building, the floor, the department, and the date and the signatures of the three persons who have made the inspection and recommendations. The third copy of the permit should then be hung on the welding or cutting equipment and the job may be started.

The welding permit shown previously is the one that we use. However, it may not be practical for other locations. It is suggested that those interested get in touch with their fire insurance companies or write to many of their major industries and obtain from them a copy of the permit being used in their activities, drawing from each of these that material which will function best in the individual operation. Upon reaching a decision, it should be ascertained that every man in the organization, from the plant manager down, is familiar with the permit procedure, knows why it has been put into effect, and how it must be used. In each organization, there should be set up either in the Fire Department or Safety Department, someone responsible for the issuing of permits and that individual should be well acquainted with every hazardous location in the plant.

The author suggests that if such a plan is not in operation in a specific plant, studies should be made at once so that a workable procedure can be set up.

A general contractor who enters industrial plants or contracts to do welding operations and finds that they have no permit procedure, should insist that on every operation bid upon, the engineers, supervision, and management of that operation should advise of every hazard that may exist. In the author's opinion, it is the contractor's responsibility to see to it that the recommendations of people such as the National Fire Protection Association, National Board of Fire Underwriters, the Factory Mutual Insurance Company, or the Factory Insurance Associations or any other such agency are followed to the letter; this can be of great help in cutting down the tremendous total of fire losses.

Conclusions

In conclusion, we can say this, that one of the causes of fire loss in the nation today is the improper use of cutting and welding equipment. We can say that unless something is done quickly, those losses will mount because welding and cutting operations are increasing daily in every industry. We can conclude that, by sound thinking and careful planning in advance of each welding and cutting operation, we can eliminate much of that loss. The method is fairly simple. The control is very, very important; the responsibility is not with the welder but is with every man from top supervision down who authorizes the use of welding and cutting within the plant.

DEVELOPMENT OF WELDING SAFE PRACTICES IN AN INDUSTRIAL PLANT

Unique way in which a safety program came into being is outlined and explained by the author

BY ROBERT L. SNYDERS

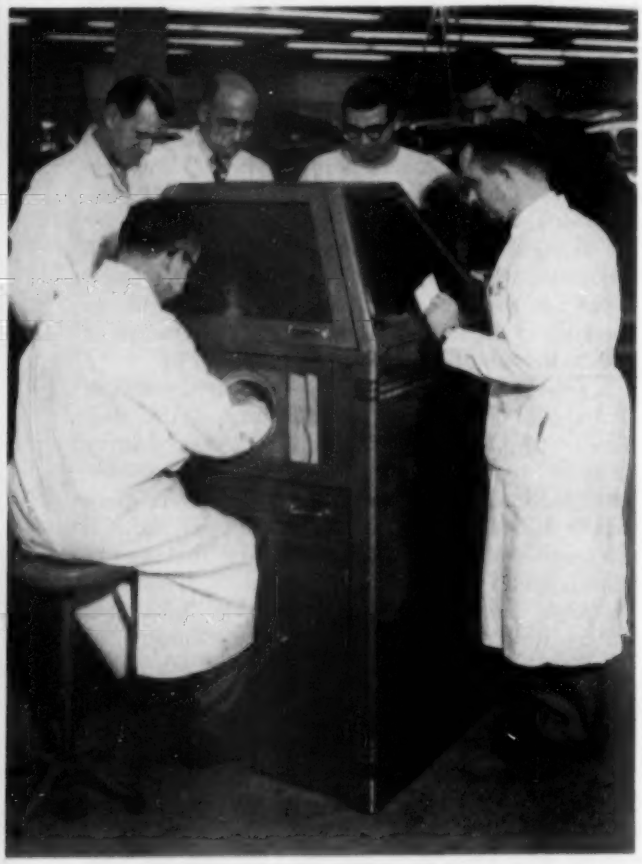


Fig. 1 Teaching safety principles at the training level. Teacher and students are fully protected from the hazards of arc welding

Robert L. Snyders is Faculty Member, Welding Section, General Motors Institute, Flint, Mich.

Presented at 1956 AWS National Spring Meeting in Buffalo, N. Y., May 7-11.

ABSTRACT. This paper explains the approach used in the development of recommended welding practices for General Motors.

It explains how in committee activity a group of welding engineers, interested in safety, accepted the responsibilities of planning, organizing and reviewing proposed recommended safe practices developed by the members of the task group.

The paper further explains how in a joint committee consisting of the welding safe practices task group and key personnel appointed by the Director of Safety and the Director of Plant Protection, acted as a "clearing house" in the review and finalizing of the present Welding Safe Practices.

The paper further explains a breakdown of the areas considered for establishing welding safe practices.

Introduction

This paper is intended to explain the unique way in which a safety program came into being. It also describes how a committee of welding engineers and supervisors interested in safety, voluntarily accepted the responsibility to plan, organize and develop welding safe practices in General Motors.

An understanding of committee activities in General Motors, their purposes and objectives may be found helpful.

Committee activities sponsored by the Production Engineering Section of the Manufacturing staff were established to provide management an opportunity for cooperative study of manufacturing problems. Divisional personnel who are assigned to engage in these activities contribute many ideas for improving manufacturing operations and increasing safety. By these activities the Corporation establishes a source of information for each technical field of manufacturing. It further provides each division with the specialized knowledge which may not be readily available within its own organization. The exchange of ideas has aided divisions and plants in keeping well informed on current developments. It was through this type of activity that the welding safe practices were developed.

Four of these committees are concerned with Equipment and Operations and eight with Materials and Processes.

The jurisdictional committees under the Equipment

and Operations group are: master mechanics, plant engineers, material handling, and chief inspectors.

Since General Motors has "decentralized operations and coordinated policies and control," these activities are a direct benefit to each division and plant in solving local operating problems.

In order to begin a safety program it was necessary to set up a committee for this activity.

In Cincinnati, in December of 1953, the Master Mechanics Welding Sub-Committee established this new working group known as The Welding Safe Practices Task Group. Its purpose was to develop recommended safe practices to serve as recommendations and guides for aiding and influencing safety in the use of welding equipment in manufacturing operations. These recommendations were to serve only as suggestions and guides because it is not within the jurisdiction of this committee to establish policies for any operating division or plant.

Three distinct needs prompted the Welding Sub-Committee to develop a safety program. The first was the request of management for a uniform set of safety procedures. It was evident that some plants could use more adequate and readily available information concerning the safe installation, operation and use of welding equipment.

Secondly, these rules and procedures would be used as guide-lines to aid and influence safety in the maintenance of welding equipment and welding operations. In some instances the use of widely varying practices had only resulted in creating additional hazards.

The third need for a safety program was that none of us today, least of all the person involved, can afford an accident. Safety procedures can well be an educational program for the prevention of fires, explosions and personal injury.

The objective of this task group was to draft recommended safe practices for safe conduct of welding, brazing and soldering operations (see Fig. 1). It would also provide for the handling, storage and use of hazardous materials and equipment required in performing these operations.

The group would recommend, "Plant Standard Practices" and "Operator Rules," that outline procedures to be followed in using gases, fluxes and other materials which present hazards of fire, explosions or personal injury.

The procedures will identify proprietary and trade-named materials with appropriate reference to basic chemicals or compounds for which hazards have been evaluated.

Perhaps it would be well at this point to define the terms, "Plant Standard Practices" and "Operator Rules." *Plant Standard Practices* are those things for which management is responsible and over which the operator has no control. *Operator Rules* are those things for which the operator is responsible for in the safe conduct of welding operations.

The First Meeting

At the first meeting in Detroit, the task group was confronted with the problems of how to most effectively develop the program to meet its objective.

After considerable questions and discussion on the methods of approach, the group agreed on the following steps, namely:

1. The Planning Step
2. The Design Step
3. The Writing Step
4. The Review Step
5. The Finalizing Step
6. The Using Step

The Planning Step

In the planning step the task group met to determine: first, for what processes the safe practices would be developed. Next, to what extent management was responsible in providing safe working conditions. Further, to what extent the operator was responsible for in the safe conduct of welding operations. And finally, how to present these recommendations to management and operators for their most effective use.

To meet the objectives of the program it was necessary to carry out these steps in order.

The Design Step

After the planning step the committee's next concern was what processes should be included, which may be called the design step. The processes for which safe practices were developed in the first draft were to include only those processes most widely used in the Corporation, namely: oxyacetylene welding, electric arc welding, resistance welding, brazing and soldering.

The task group felt it would be wise at this stage to limit its first draft to these processes in order to put something workable in the hands of the users as soon as possible.

It was agreed that management's responsibilities are those physical factors which influence safe working conditions for the prevention of accidents. These could include:

The proper design and construction of equipment.
The proper protection against the failure of equipment.
The safe installation of equipment.
The safe arrangement of equipment and material handling devices.
The proper layout of work areas.
The proper provision and proper use of protective clothing and other safety devices.
The proper storage and handling of materials (see Fig. 2).

Operator responsibilities, it was determined, are those rules or procedures he follows in the safe use and conduct in performing welding operations. These might include:

The proper use and operation of equipment.
The proper use of eye protection and protective clothing.
The proper handling and use of materials.
The proper use of safety devices and machine guards.

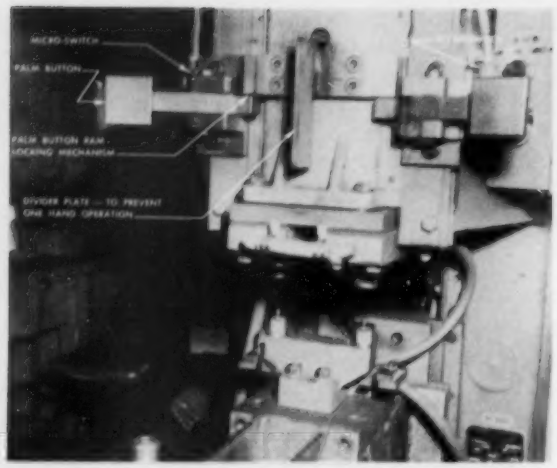


Fig. 2 Projection welder adequately protected. An example of how management can meet their responsibilities for safe working conditions

The prevention of unauthorized use of equipment.

The prevention of unauthorized repairs on welding equipment (see Fig. 3).

The Writing Step

The writing step consisted of the task group members voluntarily accepting writing assignments. They selected the welding process and area (Plant Standard Practices or Operator Rules) for which they were best qualified. The members felt that, in this way, the writers could make their greatest contribution.

Technical experience was represented in this group by welding engineers most interested in the design, construction and function of welding equipment. This group pooled their knowledge, training and background in the writing of recommendations for the management portion of the program.

Operator experience was also important in order to place proper emphasis on the operator phase of the program. The knowledge, training and experience of people in supervisory and training classifications was pooled in developing the operator rules and procedures.

In order to keep the interest of the task group at a high level and at the fast pace they had set in meetings to date, it was agreed to establish due dates for the completion of writing assignments. The time agreed upon was thirty days. There was much work accomplished in those thirty days and through their full cooperation due dates were met and the rough draft was completed.

This rough draft was then forwarded to GM Institute where it was produced in quantity and distributed to the review group. The work of the review group became the next procedure which is referred to herein as the review step.

The Review Step

It was at this stage that a third type of experience was desirable in helping the task group reach its objective. In this review phase of the rough draft, in addition to the task group, safety engineers and plant protection personnel, people interested in the prevention of accidents, fires and explosions were brought in.

The rough draft was then distributed to all members of this master review group with instructions to forward their suggested revisions again to GM Institute.

It seems unnecessary to say that many changes and revisions were suggested by the master group. These suggestions were then compiled and the first draft was put into composite form.

It was in a series of review meetings of the master group held in Detroit, that the first draft of the welding safe practices were finalized. These meetings proved very beneficial as some further suggestions and additions were incorporated into the first draft.

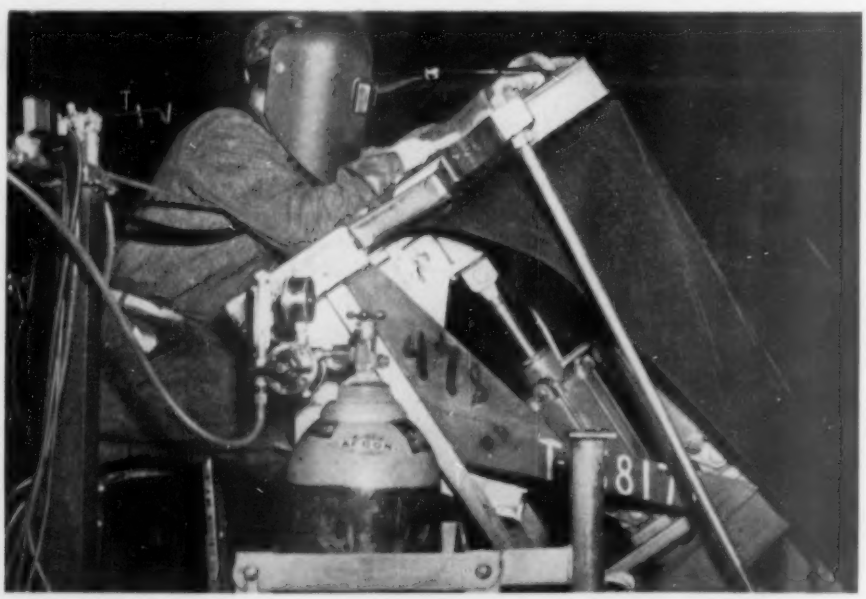


Fig. 3 An example of management and operator cooperating to produce safe working conditions in an inert-gas tungsten-arc welding operation. (Operator is properly protected by gloves, dark clothing, safety glasses and a hood with the proper shade lens)

The contents of one of the sections in the first draft appeared as:

Plant Standard Practices for Resistance Welding

- Introduction
- Protection Incorporated in
  - Design of Equipment
  - Control Circuits
  - Reduced Voltage Circuits
  - Control Panel Enclosures
  - Panel Mounting
  - Panel Wiring
  - Equipment Mounting
  - Grounding
  - Hydraulic Circuits
  - Pneumatic Circuits
  - Ventilation Systems
- Protection for Maintenance Personnel
- Mechanical Handling Systems
- Associated Equipment

The recommended safe practices include Joint Industry Conference (JIC) Standards and additional Corporation recommendations. The additional Corporation recommendations include safety devices and modifications management builds into equipment for safety purposes.

The Finalizing Step

This finalizing consisted of presenting the first draft of the welding safe practices to the parent group, the Master Mechanics Welding Sub-Committee, for approval. When approval was given, the Production Engineering Section was authorized to edit and distribute the recommended safe practices to divisions and plants in the Corporation.

These welding safe practices were also approved by the "General Advisory Committee on Hazardous Materials" and appear as a section in "Volume I of Plant Engineering for Hazardous Materials." This is a volume on the control of hazards in the use of specific materials, currently being developed by the Production Engineering Section.

The Using Step

Now, how the procedure was to be presented for most effective use presented another problem. The task group agreed the problem of presenting the safe practices to management was that of the Manufacturing Staff.

However, it was recommended that the safe practices should be included as a new section in the Manufacturing Facilities Handbook. This Manufacturing Facilities Handbook is a volume of engineering methods, procedures and specifications edited and distributed to divisions and plants by the Manufacturing Staff.

It was also recommended by the group to distribute the "Operator Rules" to operators for reference and study purposes. These rules were to be edited and distributed in pocket-size editions for convenient use by welding operators.

Summary

The work of this task group is far from being completed. We feel there are many unsafe practices and hazardous conditions this group has not experienced or investigated. We feel that we have only scratched the surface in helping to solve our safety problems.

There is every evidence that a permanent task group for this activity should be maintained to further the study of safety in welding operations. This fact has been established by the interest expressed in the form of questions, suggestions and revisions. The task group has received many communications from engineers, welding supervisors, safety personnel and plant protection people throughout the Corporation.

We in the task group realize we have made only a small contribution to the solving of a safety problem. We feel there has been a keen interest developed in the Welding Sub-Committee through their activity. This activity should be continued because of the vast opportunities for still greater improvement that is within our reach. We should explore all possibilities to see whether we can find new ways, both in engineering our operations and educating our people, that will more effectively prevent and reduce accidents. We should continue to encourage our line operators as well as our engineers and supervisors to contribute still more to solving our safety problems. The people who apply the process and are the users of the equipment may possibly be in a position to suggest a better method to further the improvement of safety in our division and plants.

Management of any large industrial organization is safety-minded in this period of rapid growth and progress. The tremendous number of new processes, new equipment and yes, new employes, all add up to a greater effort on the part of safety-minded people.

To meet this tremendous challenge of industry we must grow with it in our thinking. We must provide better safety procedures as well as develop new and better safety devices. The ultimate, of course, might be the development of welding safety training programs to suit our specific needs.

We believe that "Safety Is Everybody's Business" and that we should all work together as a team to provide the best possible solution to an ever-growing condition.

Acknowledgments

Appreciation is expressed for the efforts of the following people in reviewing the paper and supplying additional information and content:

General Motors Corp.: D. T. Mould, safety director; K. S. Hedges, associate safety director; R. R. Mitchell, contact engineer—Product Engineering.

Fisher Body Division, Central Office: L. J. Rose, senior production engineer.

General Motors Institute: M. L. Gilbert, chairman, Product Service Department; M. D. Thomas, Welding Section head, Science Department; R. B. Hamlin, faculty member, English and Cultural Studies; E. G. Bowman, Program Development; and R. P. Stapp, Program Development.

The author also wishes to thank the General Motors Institute for supplying Fig. 1, Frigidaire Division for Fig. 2, and Buick Motor Division for Fig. 3.

APPLICATION OF SAFE WELDING PRACTICES

Paper discusses seven basic principles of an established safety program, and shows how safe welding practices may effectively be put to work through such a program

BY LEON J. ROSE

Fig. 1 Basic principles of an accident prevention and health maintenance program

ABSTRACT. This paper is the sequel of a paper entitled "Development of Welding Safe Practices in an Industrial Plant" by Robert L. Snyders. In brief, Snyders' paper discussed the need for and development of a group of written safe welding practices.

This paper will discuss the seven basic principles of an established safety program. It will refer to the safe welding practices to show how they may effectively be put to work through the program.

"Safety Hazards" are defined and statistics discussed showing that most accidents are caused by unsafe acts or unsafe mechanical or physical conditions.

It further discusses how management and supervision attack the problem of accident prevention and health maintenance through engineering, education, enthusiasm and enforcement.

It concludes that as machine and welding processes improve and changes are made in industry, the safety program must be continually reviewed and of necessity must grow to meet the ever-changing needs of the industry and the plant.

Leon J. Rose is Senior Production Engineer, General Motors Corp., Fisher Body Division, Detroit, Mich.

Presented at 1956 AWS National Spring Meeting in Buffalo, N.Y., May 7–11.

Introduction

In his paper on "Development of Welding Safe Prac-

tices in an Industrial Plant," Robert L. Snyders has reported how a group of people organized, wrote, and edited a very comprehensive list of recommended safe welding practices. Now that we have this material the question arises, "How do we put it to work?"

The primary objective of this paper will be to discuss an established accident prevention and health maintenance program, and show how these safe welding practices fit into the program.

In our organization, safety is one of the operating objectives. Thus, safety is not thought of as just something that goes along with efficient production of a quality product, but as one of the specific objectives of plant operation. This attitude has become a kind of philosophy and it is as follows: as long as one employee is hurt or is affected by an occupational disease, our job in safety is not done.

A good accident prevention and health maintenance program does not just happen. Such a program is the result of careful planning and organization.

In line with this thinking, in June of 1955, H. H. Curtice, President of General Motors, released his "Seven Basic Principles of Safety." These principles, which have become a guide for safe plant operation throughout the Corporation, could be utilized by any organization as a basis for a sound safety program.

Fundamental Principles

1. Provide Active Top Management Support. A good safety record is clear evidence of good management. Accordingly, general managers and other top divisional and plant executives will make safety their responsibility, by:

Maintaining a comprehensive safety program at all times.

Meeting with key supervisory personnel at least once a month to review safety performance.

Taking any action necessary to improve safety conditions.

In thus giving its concrete support, management will imbue the entire organization with a continuing zeal for safety.

2. Maintain Adequate Safety Personnel. Each plant should have sufficient, well-trained personnel to assure continuous, careful attention to safety. A qualified man should be assigned to direct the safety program, handle safety education and assist the supervisory force in maintaining safe working conditions. The staff of safety engineers and inspectors should be sufficiently large to cover all operations.

3. Develop Safety Instructions for Every Job. Safety rules and instructions as to safe practices should be set down in written form covering each job in the plant. This material should be used as the basis for safety instruction of new employees and of employees transferred to new jobs.

4. Instruct Each New Employee. Each new employee should be thoroughly instructed in general safety policies, rules and procedures before being referred to his supervisor for job training. In turn, the supervisor should review with him thoroughly the safety measures of the particular job, before he starts to work. Subsequently, the employee should be followed up closely, to make sure he understands and is carrying out the safety instructions applicable to his job.

5. Operate Through Supervision. The supervisor is the key man in the safety program because he is in constant contact with employees. Each superintendent should hold meetings with his foremen at least once a month to review safety conditions, general safety policies and specific situations.

6. Make Every Employee Safety Minded. The cooperation of the individual employee is vital to the success of a safety program. Continued education is required to make certain that all concerned—management and employees alike—do their part in protecting the safety of the individual at all times. Every available medium—safety booklets, posters, signs and plant papers—may be used to good advantage in furthering the objectives of such a program.

7. Extend Efforts Beyond the Plant. Special attention should be given to off-the-job safety as employees have more accidents away from work than they do on the job. Our objectives should include efforts to promote the safety of employees and their families by:

Maintaining a comprehensive safety program for employees driving company-owned vehicles;

Providing material on highway safety to aid employees driving their own cars;

Encouraging employees to develop safe practices in the home, on the farm and in recreational activities;

Participating in community safety activities.

Fitting Safe Welding Practices into the Program

Organizational Setup

The above principles represent the general accident prevention and health maintenance program of the Corporation. The program is headed up by a safety director. The Corporation is made up of a number of Divisions each having its own safety director operating out of General Offices. Most of the Divisions have more than one plant.

The Industrial Relations Department in each plant, which includes both the safety and training activity, is given the responsibility for coordinating safety activities in the plant. This responsibility is usually delegated to a supervisor of safety that reports to the Director of Industrial Relations.

The primary function of this personnel is to:

1. Plan for safety.
2. Inspect for safety.
3. Check the performance of management and hourly employees to insure compliance with safety regulations.
4. Prepare educational materials for use in training management employees and material for use by

foremen and supervisors in training hourly employees.

5. Cooperate with the training department in conducting training.
6. Maintain safety records and statistics.
7. Investigate accidents and near accidents.
8. Make appropriate recommendations to higher management.
9. Take affirmative actions to promote safety as an operating objective.

Distribution of Material

Any material or information that is compiled or organized for any purpose is useless if the people that need or could utilize the material do not have access to it, or are unaware of its existence. Hence, good distribution of the material is very important.

The Corporation will make the safe welding practices available to the Divisions by incorporating it in publications which have wide distribution within the various Divisions. In our organization the publications are known as the *Hazardous Materials Manual* and the *Manufacturing Facilities Manual*. Actually for discussion purposes the names of the books are not important. What is important is that they are sent to all the major division and department heads in all the Divisions and in the Central Engineering Activities.

These personnel can then analyze the material and request as many copies of it as they feel is necessary or desirable for the persons under their jurisdiction.

In our particular Division it is anticipated that the material will be broken down further and put into 3 × 5 booklets in a form which the plant could use directly. The booklets might have titles such as:

Suggestions for the Safe Handling and Operation of . .
Gas Welding and Cutting Equipment
Arc Welding Equipment
Resistance Welding Equipment
Compressed Gases

Actually some booklets of this type are presently in existence. In such cases the material in the books will be reviewed to see how it compares with the new material. It is very likely that it will be desirable to review, revise, reword, add to, or modify the material to make it more comprehensive, more clearly stated, or in general more effective.

The booklets may then be distributed to the plants, and they in turn may put them directly in the hands of the operator through the supervisor.

Application of Material Through Four E's of Safety

Up to this point we've discussed a basic safety program, a general organizational setup, and a method of distributing material. Now let's see how this organizational setup of management and supervision uses this material to attack the problems of accident prevention and health maintenance.

They attack the problems through what we call the Four E's of safety. They are:

1. *Engineering*—as it relates to: The proper safeguarding of machinery, equipment, materials and working conditions.
2. *Education*—as it relates to: The proper preparation of the employee to work in the plant and department; instructions in the right way to perform tasks; enlisting the employees cooperation in avoiding and eliminating safety hazards.
3. *Enthusiasm*—as it relates to: The development of a wholehearted support of a safety program by each employee and active participation in prevention or elimination of hazards.
4. *Enforcement*—as it relates to; The discipline of a group of people working under conditions essential to safe and efficient production.

Engineering

The objectives of engineering as applied to safety hazards are to:

(*a*) Avoid the hazard.
(*b*) Eliminate the hazard.
(*c*) Protect against the hazard.

At this point let's define safety hazard: A safety hazard has been defined as an unsafe act or mechanical or physical condition that could cause injury to or jeopardize the health of an employee.

Now let's look at some statistics to see what it would mean to our safety program if we could eliminate safety hazards.

Of 95,000 work accidents reported in Pennsylvania in 1952 (shown in 1955 Accident Facts) there was an unsafe act committed in 94.9% of the cases. Of these same 95,000 work accidents an unsafe mechanical or physical condition existed in 94.5% of the cases. From these figures it is obvious there was an unsafe mechanical or physical condition as well as an unsafe act in practically every accident.

With such facts in mind, where is there a better place to put safety to work than in engineering? Avoiding and eliminating hazards in machinery is usually accomplished by designers and engineers. These people can avoid hazards by:

1. Looking at tools to see if they are designed as to make guards unnecessary.
2. Providing mechanical feeding devices when practicable.
3. Providing remote control operating mechanisms when practicable.
4. Designing lubrication systems which can be reached without moving guards.
5. Laying out department with safety in mind.
6. Getting help of experts while planning.
7. Considering safety when tools and equipment are bought.

Following are some specific examples of items covered in the *Resistance Welding Section* of the *Safe Welding Practices*.

1. "On press welding setups provisions should be

made to open both sides of powerline feed to the transformer."

2. "Pressure switches should not be used alone to determine sequence of operation."
3. "Control voltage to the 'push button' of any type switch which normally requires a full grasp by operator to initiate (such as switch in handle of a portable gun) should be a maximum of 24 volts."
4. "Fire-resistant type fluids should be used in all hydraulic equipment whenever possible and in all cases where relatively large volumes of oil are being circulated under high pressure."

Items of this type concern the design of the equipment and the associated electrical, hydraulic and pneumatic circuits.

When these actions are taken in relation to the original design they are known as "avoiding" the hazard. Changing the design to incorporate safety features after the machine is in the plant is an engineering objective to eliminate the hazard.

Examples of activities involved in eliminating hazards might include items such as:

1. Providing mechanical devices that remove the hands or other parts of the body from the danger zone.
2. Designing guards so machine will not run unless guards are in place.

To correct or protect against hazards through change in handling materials, several provisions in plant layout could be included to meet the engineering objectives. Items such as:

1. Isolation of hazardous processes in other buildings or specified areas.
2. Providing safe access to every place the employee must go.
3. Providing adequate area in which to service machines and equipment.

It may be noted that these items just discussed, in regard to engineering, concern the activity and responsibilities of all the various engineering departments such as Production Engineering, Works Engineering, Process Engineering, Die Engineering, Plant Engineering and Master Mechanic Activity. As is the case in practically any department in any organization, these departments are subject to personnel changes due to rotation, advancement and hiring of new employees. Because of this, the need for written guides such as *Safe Welding Practices* cannot be overemphasized.

Education

The objectives of education as applied to safety hazards are to:

(*a*) Orient the worker in the plant and department.
(*b*) Instruct the worker in the correct way to perform tasks.
(*c*) Enlist the worker's cooperation in avoiding and eliminating hazards.

Usually when an employee is hired he is given a talk on the general safety policies and practices of the plant by some member of the Industrial Relations or Safety Department. He may then be given a booklet (such as those just discussed) which is applicable to his specific job. The foreman or supervisor will then discuss the safety rules, regulations or equipment peculiar to the particular operation on which the employee is to be placed. He will then quiz him on the contents of the booklet to be sure the employee understand them. The last page of the booklet is an employees acknowledgment that he has read the safety rules and expects to be guided by them. This acknowledgment is signed by the employee and the foreman. Space is also provided for any comments the foreman may wish to make. The sheet is then dated, removed from the book, and sent to the Safety Department as part of the employees permanent record.

Each plant has its own individual safety problems and has conditions that are peculiar only to their operation. They may therefore make use of the Corporation and Divisional safety policies and material or formulate their own, based on Corporation policy, in order to meet more effectively their individual safety problems.

Industrial safety education is generally made up of meetings, talks and office contacts by safety specialists and members of supervision. Bulletins, posters, reading material, films and special instructions are also used.

Of these items, the most effective has proved to be direct safety talks by the foreman with members of his own department. The foreman is in a position to take the safety messages out of the posters, bulletins, and other safety material and discuss it directly with the employee. It gives the employee a chance to express his ideas on how his job could be performed more safely or to ask questions regarding safety policies on items which may not be clear to him. It also gives the foreman an opportunity to express his satisfaction with the safety habits of the employee.

The purpose of this activity is, of course, to help the worker become safety conscious in the hope that he will be able to sense the existence of unsafe practices and conditions and will avoid them of his own volition. This leads up to the next big "E."

Enthusiasm

The objective of enthusiasm as applied to safety hazards is to develop an enthusiastic mental attitude of the employee with respect to the safety program.

It has been found that employees may be talked to, talked at, read to, shown films and posters, yet fail to apply the safety messages.

The primary reason for this is that the employee was never actually convinced that his participation in the program was important to him, his family, his fellow worker, or the organization for which he works. Of these things the employee must be convinced.

There is one factor which stands out as being essen-

tial in building this employee enthusiasm—*sincerity*. Management and supervision must be sincere in their desire to meet the objectives of the safety program. For example, how could an employee be expected to obtain or retain his enthusiasm if he pointed out an existing hazard or potential hazard and immediate corrective action was not taken, or if the employee was required to wear safety glasses and safety shoes but the supervisor in the same area did not?

Our organization utilizes the suggestion plan to the utmost in this connection. A very high percentage of safety awards have been made. This is tangible evidence to the employee that management is sincere.

Enforcement

The objective of enforcement as related to safety is to maintain an orderly performance and eliminate all accidents. It is not to force people into obeying hard and fast rules, and is best obtained through leadership rather than by a display of authority. Enforcement is mainly dependent upon the effectiveness of the follow-up systems used with the educational and enthusiasm stage. In considering enforcement the personnel concerned will want to:

1. Make sure all employees know the application of all safety rules.
2. Make sure all employees understand the purpose of each safety rule.
3. Step up to things immediately at the time they happen.
4. Report to the right persons any safety rules which do not work, along with the reasons for their ineffectiveness.
5. Set up and use an effective follow up for accident prevention and health maintenance.

If the safety objectives have been attained through engineering, education and enthusiasm, the enforcement of safety activities though important, should cause the supervisor few problems.

Conclusion

Any successful safety program will constantly need reviewing and revising, if not in principle, at least of specific rules or method of application. This is true because of the need for continuous and adequate training of personnel. This continuous training is necessary because of new personnel and rotation of existing personnel; improvement of available safety equipment; and improved machinery, welding processes, and equipment; and progress in industry.

"Safety Is Everybody's Business," and since welding plays such a prominent part in industry today, persons concerned with welding in any manner have a great responsibility.

Finally, let's refer to Fig. 1. It will be noted that the basic principles of the safety program just discussed are shown as segments of a circle which represents an accident prevention and health maintenance program. As is characteristic of a circle, there is no one starting point in regard to safety, but even more important, there is no stopping point.

Acknowledgments

The author gratefully acknowledges the efforts of the following people for reviewing the paper and supplying information and content:

General Motors Institute: E. G. Bowman, Program Development Department; Robert P. Stapp, Program Development Department; Grady G. Stubbs, English Department.

General Motors Corporation: David T. Mould, safety director; Kenneth S. Hedges, assistant safety director.

Fisher Body Division: Robert T. Daniels, safety director; Clayton R. Lenox, senior production engineer; John F. Cantalin, engineer-in-charge.

Reference Material

The following references proved useful:

A booklet entitled "Safety in General Motors," designed and developed by the Division and Personnel Staff of General Motors Corporation in cooperation with General Motors Institute and distributed to General Motors personnel.

A talk entitled "The Battle That Never Ends," by R. A. Boehne, General Director Industrial Relations, Fisher Body Division, from a booklet entitled "General Motors Fifteenth Annual Safety Conference"—Chicago Ill., Oct. 18, 1954.

100 HOURS SAVED BY OXYGEN CUTTING

Heavy shape cutting saves machining time and material costs

BY C. G. DAVIS

Precision oxygen cutting through 26-in. steel thickness added a new service to the steel plate distribution operation of Burger Iron Co., Akron, Ohio and, saved valuable man-hours and material for their customer, Superior Mold and Die Co., Stow, Ohio.

When Superior asked Burger Iron to cut and furnish the heavy steel sections for dies for automobile weather-strip molds, the job presented a real challenge. While multitorch precision oxygen cutting has long been a production feature, and cutting thicknesses up to 15-in. standard practice, the problem here was tougher. It meant shape cutting through a 26-in. section of 20/30 carbon forging-quality steel, and holding it to rigid tolerances.

Careful study was given to torch drag, an inherent problem in a shape cut of this thickness, along with proper torch and tip, style and size, preheat and cutting-oxygen pressures, travel speed, kerf width etc., any one of which if miscalculated could have turned the job into expensive scrap.

The decision was to use a water-cooled torch mounted on an oxygen-cutting machine equipped with electronic tracer (see Fig. 1). To minimize initial starting drag, an oxygen lance started the cutting.

This heavy shape-cutting operation means that two pieces are obtained from *one* block of steel, instead of the two blocks formerly required, and many hours machining time and valuable material are saved (see Fig. 2).

Thus a new chapter in extending the scope of steel warehouse operations has been added through effective use of oxygen-cutting products and processes.

C. G. Davis is a Technical Representative, Cleveland District, Air Reduction Sales Co., New York, N. Y.

Fig. 1 Heavy flame cutting through 26-in. steel thickness at a speed of 2 ipm with flame-cutting machine.

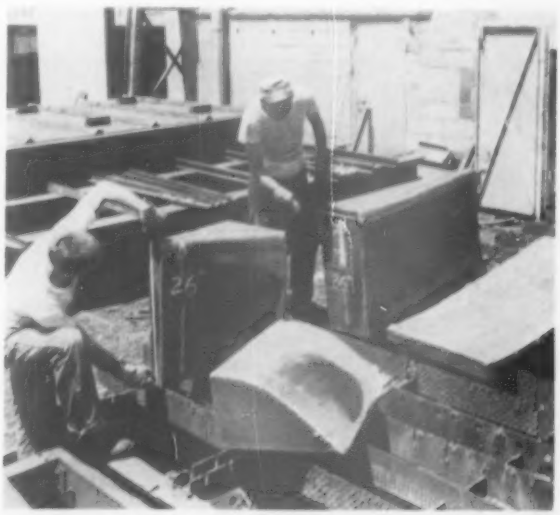


Fig. 2 One block of 26-in. steel flame cut into two pieces ready for final finishing. Quality of cut saves many hours machining

UNIQUE BOX CAR REBUILDING PROGRAM COMBINES SPEED AND EFFICIENCY

In a rebuilding program recently completed by Seaboard Airline Railroad Co., 200 box cars were stripped of their worn, wooden sides and modernized with submerged-arc welded all-steel side walls at considerable time and cost savings. Two submerged-arc welding machines teamed with a turnover jig are responsible for the high production speed and efficiency attained. By using the submerged-arc process, average welding speed was tripled and weld quality vastly improved. The use of a turnover jig to flip the cars on their side greatly facilitated handling (see Fig. 1).

The first operational step was removing wooden sides. Next, $^1/_8$-in. thick steel side plating was tack welded to the frame. Butt seams were placed over the car side posts which later served to back up submerged-arc welding (see Fig. 2). Box cars then moved on to the turnover jig. Here, each car was hoisted off its trucks, tipped, and rested on its side (see Fig. 3).

To assure clean sheet edges, all joints were sand blasted just before the submerged-arc welding operations started. Two carriage mounted submerged-arc welding machines then made a series of eight 8-ft. 3-in. long butt welds and two 14-ft. 6-in. long fillet welds per car side. Completed welds required no postweld treatment.

Based on a story by The Linde Air Products Co., New York, N. Y.

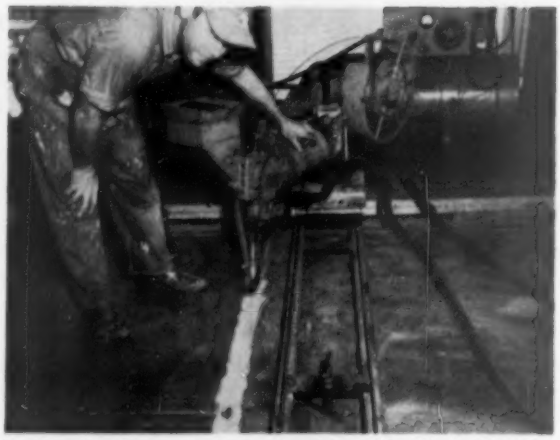


Fig. 2 Making a high-speed butt weld in box car side. In this operation car side posts served to back up submerged-arc welding

Upon the completion of one side, a box car was hoisted, spun 180 degrees, and set down for the second side to be submerged-arc welded. Employing seven welders and two helpers, production averaged four rebuilt box cars a day.

Fig. 1 Hoisted free of its trucks, this box car is easily spun 180 deg to allow submerged-arc welding on each side

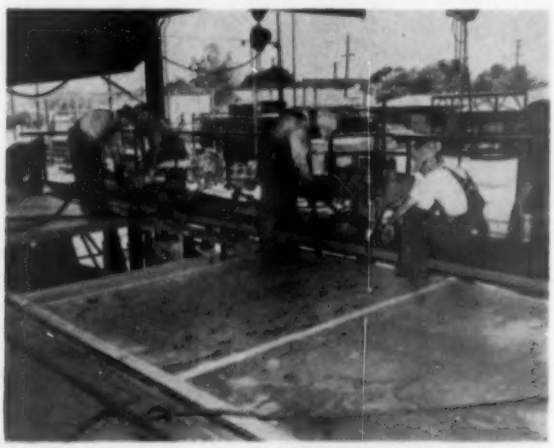


Fig. 3 A box car on its side in the turnover jig. Welders completed these fillet welds three times faster with submerged-arc welding than with methods formerly used

Society News

E. W. Bliss Enrolls as a Sustaining Member

The E. W. Bliss Co., 1375 Raff Road, S. W., Canton, Ohio, has recently become a sustaining member of the AMERICAN WELDING SOCIETY.

To meet the ever-growing production requirements in the field of heavy weldments, the E. W. Bliss Co. has complete welding and flame-cutting facilities at its Canton and Salem, Ohio, plants. The facilities include stress-relieving furnaces, radiographic equipment and big multitorch machines that can cut material ranging up to 14-in. armor plate.

All the modern welding methods are used: metal-arc covered electrode, inert-gas-shielded arc with consumable or tungsten electrode, oxyacetylene and submerged arc.

E. R. Lewis has been appointed sustaining member representative.

Sustaining Membership Taken Out by Shieldalloy

Shieldalloy Corp., Newfield, N. J., is one of the largest US and Canadian suppliers of welding rod coating materials; they also supply the steel industries with various metals and alloys. Shieldalloy columbium and tantalum metals are widely used in electronic and atomic applications. Shieldalloy products can be broken down into the following categories: Welding and powder metallurgy industries, with such products as chromium metal "98," ferro chromium, ferro columbium, ferro columbium-tantalum, ferro manganese, ferro titanium, ferro tungsten, ferro vanadium, and titanium aluminum. These are, of course, "powdered metals and alloys." In this same industrial bracket, under the heading "processed minerals and ores," Shieldalloy supplies chromite, fluorspar, hausmannite, ilmenite, iron carbonate, iron oxide, kaolin clay, rutile, and zircon and zirconium silicate.

They supply chromium metal "98" and "99" ferro columbium, melting base alloy, and zircon sand and flour for the steel, foundry and nonferrous metallurgical industries.

Shieldalloy's sales force and plant facilities are located on West Boulevard, Newfield, New Jersey. They are a division of Metallurg, Inc., 99 Park Ave., New York 16, N. Y.

S. W. Madsen is the sustaining member representative.

Gar Wood Industries Now a Supporting Company Member

One of the most recent additions to the fast-growing list of supporting company members is the Gar Wood Industries, Inc., Findlay Division, Findlay, Ohio. The membership has been authorized by J. E. Dipert, plant engineer, and became effective on September 1.

British Institute of Welding Elects Top Officers

Sir Charles Lillicrap, K.C.B., M.B.E., D.Sc. (Eng.), has been elected president of the Institute of Welding for 1956–57 and was installed at the annual general meeting of the Institute on July 19th. Mr. J. Strong, M.A., a director of British Oxygen Engineering Ltd., has been elected vice-president.

Plummer Honored by Japan Welding Society

Fred L. Plummer, past president of the AMERICAN WELDING SOCIETY, was recently made an Honorary Member of the Japan Welding Society. Mr. Plummer is the second foreign person to be so honored by Japan.

The certificate awarded Mr. Plummer reads as follows: "This is to certify that in view of the conspicuous service you have rendered to the progress and development of welding technology and its applications, you are unanimously recommended and accepted as Honorary Member of Japan Welding Society in accordance with Article 9 of the By-laws of the Society."

Mr. Plummer visited Japan in April 1956. During his stay there he presented a talk before the Japanese welding group.

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Automotive industry swings

See it at the Metalworking Show

The WEST-ING-ARC CO_2 process can be seen in action at the Metalworking Show in Cleveland, October 8 thru 11, Booth 1711.

to WEST-ING-ARC CO_2

...to get 30% faster welds — at 50% less cost

The automotive industry, and other industries as well, are constantly proving the multiple advantages of new WEST-ING-ARC CO_2 on high-speed production lines—for the welding of frames, spring seats, rear-axle housings, drive and transmission housings, bumper jacks, etc.

Like these high-volume producers, you'll find you get sound welds without spatter . . . without preliminary preparation . . . without after-cleaning . . . without grinding . . . no time-outs. Here are some of the outstanding features of WEST-ING-ARC CO_2:

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- Constant potential selenium rectifier-type power supply with automatic voltage compensation

All this—and at greater operating savings for you!

Call your local Westinghouse welding specialist today. He will be glad to show you how you can increase your high-volume weldment production with WEST-ING-ARC CO_2. Or, write to Westinghouse Electric Corporation, Welding Department, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21976

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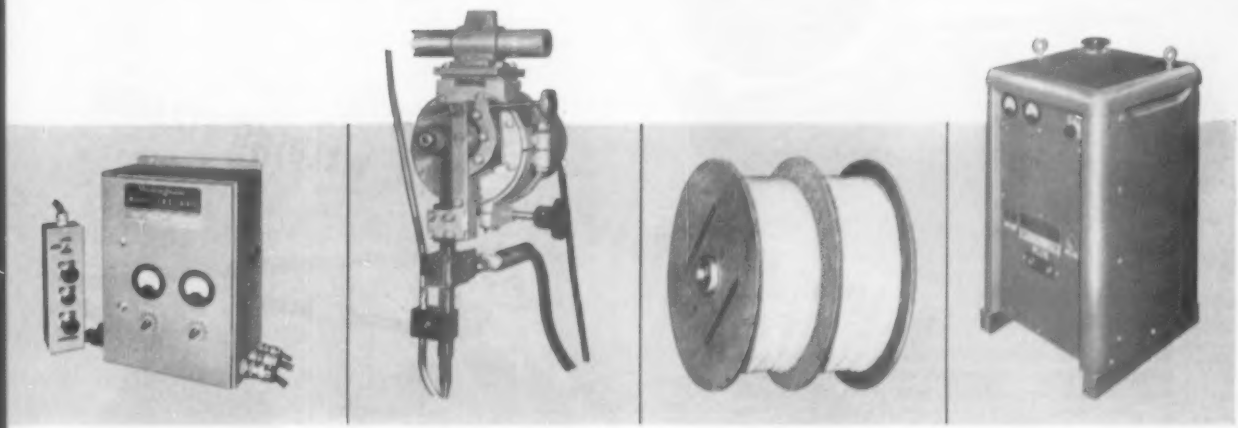

WEST-ING-ARC CONTROLS are housed in a NEMA Type 12 enclosure and conform to J. I. C. standards. The enclosure is dust-tight and contains a safety interlock which disconnects the control circuit when the door is opened.

HEAVY-DUTY WELDING HEAD includes a side-delivery nozzle to eliminate spatter and slag deposits. It consists of a reversible, variable, slow-speed ¼ hp frame motor, geared to a spur-type gear train, plus a knurled drive roll to feed the wire.

TYPE MS-21 WIRE is a mild steel copper-flashed wire specifically designed for use with carbon dioxide shielding gas. This is a high-quality welding wire with a vitally controlled analysis. It may also be used for inert gas welding (reverse polarity).

RCP WELDER supplies 600 amps at 34-volt load; is dependable and service-proved, like the Westinghouse RA welder. Current adjustments are automatically predetermined by the rate of wire feed. Output can be varied between 12 and 40.5 volts.

AWS-AFS CAST IRON GROUP MEETS

Pictured above are some of the members of the Joint AWS-AFS Committee on Welding Iron Castings who met in May at the U. S. Naval Engineering Experiment Station in Annapolis, Md. At this meeting, an extensive cooperative program of welding and testing gray, nodular and malleable cast iron was arranged. Left to right are Bela Ronay, U. S. Naval Engineering Experiment Station; S. E. Kelly, Eberhard Mfg. Co.; J. E. Fitzwater, International Harvester Co.; H. V. Inskeep, Linde Air Products Co.; Ed Fenton, acting secretary, AWS Headquarters; J. S. Vanick, chairman, The International Nickel Co., Inc.; K. Cann, Ingersoll-Rand Co.; B. F. Shepherd, Ingersoll-Rand Co.; W. M. Spear, Worthington Corp.; S. Low, vice-chairman, Chapman Valve Mfg. Co.; S. T. Walter, Air Reduction Sales Co. Also present, but not in the photograph, were C. H. Burgston, Deere and Co., and W. W. Edens, Allis-Chalmers Mfg. Co. (Official U. S. Navy photograph)

EMPLOYMENT SERVICE BULLETIN

Position Vacant

Mechanical Engineer. K-G Welding Equipment Division offers an unusual opportunity to an experienced design and development engineer on gas welding and cutting apparatus. If you are stymied and are ready to take a position of senior responsibility with an alert growing organization, send your qualifications in confidence to B. H. Van Dyke, Air Products, Inc., P.O. Box 538, Allentown, Pennsylvania.

Services Available

A-689. Wanted: Permanent position as welding engineer. Age 32. B.S. degree, physical metallurgy. Eight years extensive experience involving research in ferrous and nonferrous materials and welding methods; thorough background in application of consumable electrode welding (argon and CO_2 gases, submerged arc process, inert-gas welding and arc-welding electrodes); work directly with design and production engineers.

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THE LEWIS "UNIVERSAL" AUTOMATIC WELDING FIXTURE
This versatile automatic welding head manipulator makes precision longitudinal and transverse welds, both internal and external, with robot-like consistency and machine tool accuracy. Its speed and ease of alignment greatly reduce set-up times and overall costs for large intricate weldments.
Easily moved by overhead crane, the LEWIS "Universal" can be used for repetitive production or special set-ups. Both track-type and pedestal-type models are available in a range of sizes.
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Section News and Events

as reported to Catherine O'Leary

PROGRAM OF MEETINGS

Pittsburgh, Pa.—The *Pittsburgh* Section announces the following program of meetings for the season starting with the October meeting.

Oct. 17, 1956—"Metallurgy of Stainless Steel," William T. DeLong, Metallurgist in Charge of Quality Control, McKay Co., York, Pa.

Nov. 21, 1956—"Welded Steel Wind Tunnels," Ludwig Adams, research engineer, Pittsburgh-Des Moines Co.

Jan. 16, 1957—"Large Weldments Fabrication," John L. Lang, welding engineer, Lukenweld Division, Lukens Steel Co., Coatesville, Pa.

Feb. 20, 1957—"Hi-Temperature Alloys," Frank M. Richmond, manager, Materials Research, Universal Cyclops Steel Corp., Bridgeville, Pa.

Mar. 20, 1957—"Compressed-Air Arc Cutting and Gouging," Myron D. Stepath, president, Arcair Co., Lancaster, Ohio.
"Cutting Aluminum Alloys," Paul B. Dickerson, project engineer, Alcoa Process Development Laboratories, Aluminum Company of America, New Kensington, Pa.

Apr. 19, 1957—Twentieth Annual Tri-State Ladies Night and Dinner, Georgian Room, Webster Hall Hotel. Entertainment, door prizes, music, guest speaker. No afternoon technical session.

All of the above meetings, with the exception of the April meeting, will start at 8:00 P.M. and will be held at the Mellon Institute of Industrial Research, Oakland, Pa.

STEEL CASTINGS

Shreveport, La.—"A New Look at Steel Castings" was the subject of a talk by J. H. Lowe, vice-president, Kemalloy Corp., Shreveport, given at the July 19 meeting of the *Shreveport* Section held at the Caddo Hotel. Mr. Lowe covered the history of steel castings. He explained how castings are being accepted more than ever before in critical places such as for crane hooks. Educating the public and the outstanding record of castings in service has been responsible for wide acceptance of castings. Mr. Lowe described strength of castings, where used, quantity produced, etc. He also compared the physical properties of castings to steel plate.

INERT-GAS WELDING

Shreveport, La.—The August 16th dinner meeting of the *Shreveport* Section was held at the Caddo Hotel. The main speaker of the evening was Harry Huff [illegible], of the Air Reduction Sales Co., Houston, Tex. Mr. Huff talked on the subject, "Inert-Gas Welding of Aluminum."

The aluminum industry is one of the fastest growing major industries in the United States. For many years there was only one aluminum producer but others entered this field during and since World War II.

Because of research new aluminum alloys with better physical properties and welding characteristics are being developed. For example, the aluminum-magnesium alloys have relatively high tensile strength and good ductility after welding.

The heat-affected zone is the critical point in aluminum weldments. In this zone the grain structure is changed to that of a cast material. Any increase in strength of aluminum because of heat treatment or work hardening is destroyed by welding.

Inert-gas shield protects the molten puddle from atmosphere and its ionization path. Certain mixtures of

SECTION MEETING CALENDAR

OCTOBER 16

NEW JERSEY Section. Dinner at 6:30 P.M. Meeting at 8 P.M. at the Essex House Hotel, Newark, N. J. "Tool and Die Welding," by Richard K. Lee, Alloy Rods Co.

OCTOBER 17

PITTSBURGH SECTION. 8:00 P.M. Mellon Institute of Industrial Research, Oakland, Pa. "Metallurgy of Stainless Steel," by William T. DeLong, McKay Co.

OCTOBER 29

OLEAN-BRADFORD Section. Castle Restaurant, Olean, N. Y. Joint meeting with American Society of Mechanical Engineers. "Product Design for Welding," by John Mikulak, Worthington Corp.

NOVEMBER 2

NORTH CENTRAL OHIO Section. Dinner at 6:30 P.M. Meeting at 8 P.M. Talbot Hotel, Galion, Ohio. "Welding Fosters Diversification in Shipyards," by Ralph Bradway, New York Shipbuilding Corporation. Movie "Iron Ore from Cerro Bolivar." To be shown through the courtesy of Bechtel Corp.

NOVEMBER 9

COLUMBUS Section Panel. Educational Series. "Arc Welders Power Supply."

NOVEMBER 13

DAYTON Section. Dayton Engineers Club. "Tool Room Welding," by F. E. Kessler, Welding Equipment and Supply Co.

NEW JERSEY Section. Dinner at 6:30 P.M. Meeting at 8 P.M. Essex House Hotel, Newark, N. J. "New Techniques in Inert-Gas-Shielded Arc Welding," by J. D. Carey, General Electric Co.

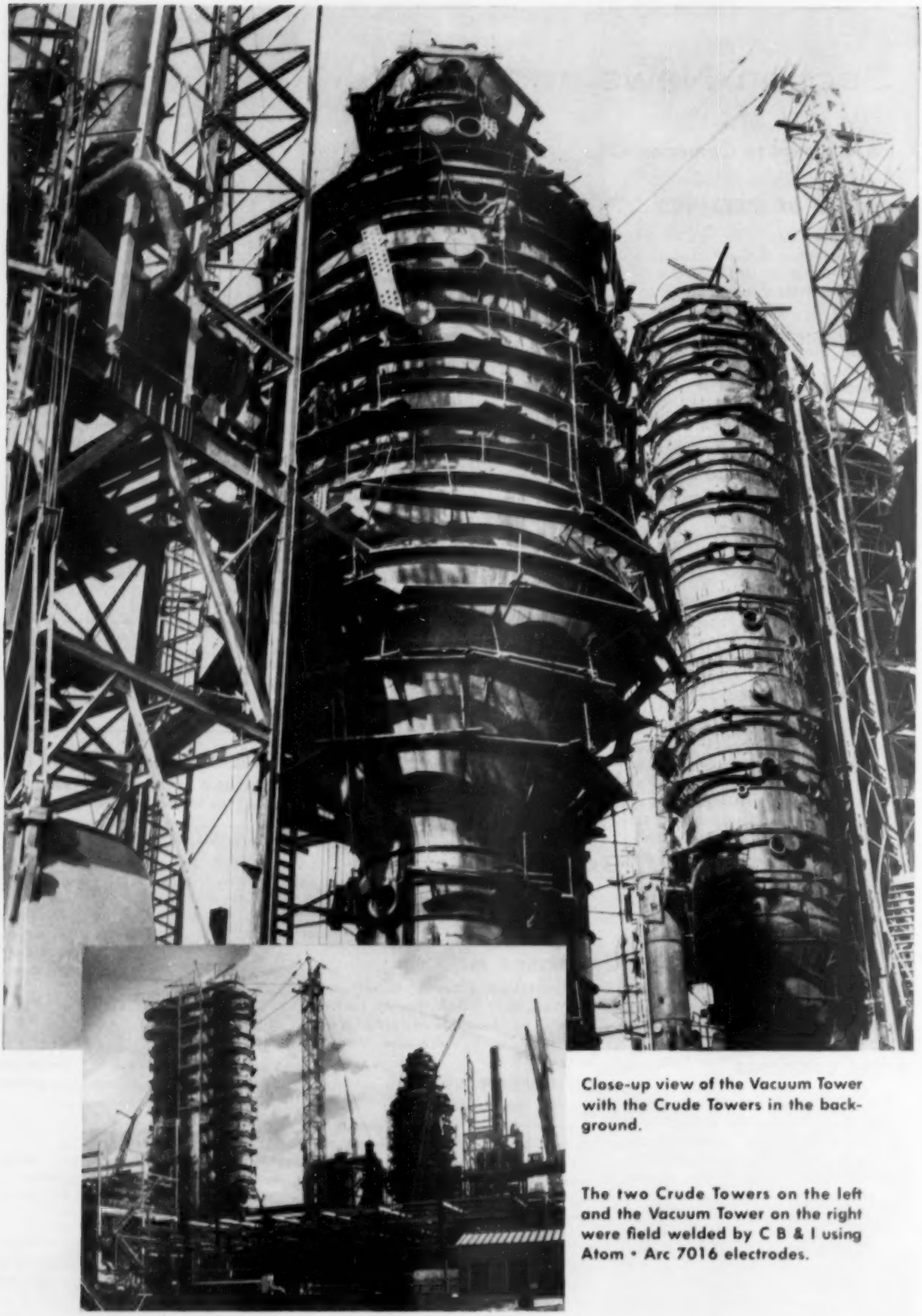
NOVEMBER 20

OLEAN-BRADFORD Section. 7:00 P.M. Valley Hunt Club, Lewis Run, Pa. "Control and Correction of Welding Distortion," by LaMotte Grover, Air Reduction Sales Co.

NOVEMBER 21

PITTSBURGH Section. 8:00 P.M. Mellon Institute of Industrial Research, Oakland, Pa. "Welded Steel Wind Tunnels," by Ludwig Adams, Pittsburgh-Des Moines Co.

Editor's Note: Notices for January 1957 meetings must reach Journal office prior to November 1, so that they may be published in December Calendar. Please give full information concerning time, place, topic and speaker for each meeting.



Close-up view of the Vacuum Tower with the Crude Towers in the background.

The two Crude Towers on the left and the Vacuum Tower on the right were field welded by C B & I using Atom • Arc 7016 electrodes.

Welded with ATOM-ARC 7016

CB&I reports more than 1 1/4 miles of field welds with less than 1/5 of 1% of X-rayed welds chipped and re-welded!

Chicago Bridge & Iron Company, one of this country's leading builders of tanks and processing structures, used Atom • Arc 7016 electrodes on this field erection job at the Sinclair Refinery in Marcus Hook, Pennsylvania. Their report on the building of this 138-foot Vacuum Tower and the two 176-foot Crude Towers makes amazing reading. For example, on the Vacuum Tower there were 2500 feet of field welds with only 8 inches of X-rayed welds that had to be chipped out and re-welded.

A summary report shows that there were 649 X-rays made on the job. 626 were satisfactory, 23 showed defects of one kind or another but only 15 were defects in field welding. A total of 6720 feet of welds (over 1 1/4 miles) were made with Atom • Arc 7016 electrodes and only 12 feet of X-rayed welds had to be chipped out and re-welded (less than 1/5 of 1%)!

All stainless clad sections in these towers were welded with Arcaloy 309 Stainless Steel Electrodes.

Quality workmanship is the paramount consideration at Chicago Bridge & Iron. Their report on this Sinclair job is enough to indicate that they get this high quality with Atom • Arc electrodes.

You'll want "Atom-Arc quality" on your jobs too. Contact your Alloy Rods Company distributor or write for informative Data Sheets.

Hortonspheroid® Storage Tank at Sinclair site, majority welded completely with Atom • Arc electrodes.
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General Offices and Plant
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no finer electrodes made . . . anywhere

argon and helium give better arc stability, sounder welds, and deeper penetration than argon.

These are a few of the remarks on the subject as covered in Mr. Huff's talk.

EXECUTIVE COMMITTEE MEETING

Miami, Fla.—A meeting of the Executive Committee of the *South Florida* Section was held at the Miami Welding Supply Company's office on August 15.

The new meeting place, starting September 19, was announced as the Melrose Hall at 2701 N.W. 28th St., Miami. A buffet before the meeting and an open forum after each meeting are planned.

DISTRICT MEETING

Birmingham, Ala.—The Southeastern District meeting was held in the Colonial Room of the Bankhead Hotel in Birmingham on August 3rd. A district executive committee and a district nominating committee were appointed. A review of the Sections in the District was presented by the district director.

Program arrangements also came up for lengthy discussion. The importance of getting speakers for local interest, applying to area problems, was discussed. Good attendance determines ability to get good speakers for future meetings. Joint meetings with other societies are very beneficial. These were some of the points discussed.

Motion was made to hold the next district meeting at the Lookout Mountain Hotel near Chattanooga, Tenn., on June 7th and 8th, 1957, with the business meeting being held on the 7th.

SECTION OFFICERS CONFERENCE

Minneapolis, Minn.—*District 8* held an Annual Section Officers Conference on July 20 at the Calhoun Beach Hotel. A total of 27 officers representing eight Sections attended. A 6-hr business meeting was held with District Directors Jackson and Singleton presiding.

A report was made on last year's activities by a representative from each Section during which questions were asked and a free exchange of ideas resulted.

Immediately following adjournment of the meeting, special group meetings were held to line up speaker circuits and programs for the coming year.

The 8th District Annual Section Officers' Conference was well attended. At the head table are (*left to right*) C. M. Clogston, John Markwell, Frank Singleton, Horace Jackson, A. P. Demmer and R. H. Schleuder. Around long table (starting *upper left*) are C. Brinton Swift, John Mascarello, Gene Coleman, Ed Looney, Ted Lowe, Gene Carnes, Roy Williams, L. A. Morehead, Dave Dallman, S. V. Williams, S. H. Palmer, Roger Griffis, Lillian Polzin, Wm. Newton, Myron Quantic, Harvey Gillerman, George Bland, Jack Kilkenny and H. E. Nelson

8TH DISTRICT ANNUAL SECTION OFFICERS' CONFERENCE HELD IN MINNEAPOLIS ON JULY 20

Members and wives at 8th District Section Officers' Conference enjoying Smorgasbord at Calhoun Beach Hotel, Minneapolis

Frank Singleton (*left*), newly elected director, is shown receiving documents from Horace Jackson, immediate past director.

New Members

Effective August 1, 1956

MEMBERSHIP CLASSIFICATION

A—Sustaining Member B—Member C—Associate Member

D—Student E—Honorary Member F—Life Member

Total National Membership August 1, 1956	
Sustaining Members	129
Members	5,529
Associate Members	5,868
Students	159
Honorary Members	9
Life Members	15
Total	11,709

AWS Builds Men of Welding

BIRMINGHAM

Bush, Joseph R. (B)

BOSTON

Baker, Arthur K. (B)

CANADA

Cleghorn, C. H. (B)
Driedger, C. (B)
Somerville, Floyd E. (B)

CHICAGO

Herrick, G. R. (C)
Reickert, F. A. (B)

CLEVELAND

Flowers, Roy (B)
Wylie, Robert D. (B)

COLORADO

Thurman, Billy G. (B)

COLUMBUS

McPherson, Robert F. (C)
Weare, Norman E. (C)

DALLAS

Dunfee, Henry H. (B)

DAYTON

Fesker, R. C. (C)

DETROIT

Brisky, Robert W. (B)
Leeser, D. O. (B)
Longyear, Marvin R. (C)
McGraw, Robert E. (B)
Piasecki, Tadeusz L. (B)

EAST TEXAS

Sorensen, Walt W. (B)

FOX VALLEY

Vande Bogart, Earl, Jr. (C)

HARTFORD

Kellogg, Robert H., Jr. (C)

HOUSTON

Bryan, Peyton (B)
Morrison, O. J. (B)
Salm, Morris T. (C)

INDIANA

Sivertsen, David R. (C)

LONG BEACH

Beard, Darrell F. (C)
Daugherty, Donavon (C)
Golgart, Lester R. (B)
Tanaka, Tom T. (C)

LOS ANGELES

Barnes, Kenneth (C)
Benson, Clifford L. (D)
Briney, Glenn W. (B)
Close, Donald C. (B)
Deuchler, Philip G. (C)
Fiora, Frank (B)
Herold, David W. (C)
Knudsen, Bob (D)
Leaming, Clyde L. (D)
Negrette, J. M. (B)
Planner, Bernard P., (C)
Seagren, Harry A. (C)
Smith, Richard S., Sr. (B)

MAHONING VALLEY

Keeler, Richard D. (B)
Moffett, Ralph (B)

NEBRASKA

Brackett, Claude (C)

NEW JERSEY

Andriola, Edward (B)
Wisman, Alfred (B)

NEW YORK

Adler, Arthur (C)
McCracken, John N. (B)
Phillips, Maurice J. (C)
Swartzell, Keith L. (B)

NORTHWEST

Anderson, William R. (B)

PHILADELPHIA

Bowers, Robert W. (C)
Connelly, Charles (C)
Rohrich, Andrew C. (B)

PITTSBURGH

Simmons, Robert E. (C)

RICHMOND

Tackett, Donald E. (B)

ROCHESTER

Houle, James E. (B)
Pike, E. G. (B)

ST. LOUIS

Zeppenfeld, H. B. (C)

SAN FRANCISCO

Alm, Robert D. (C)
Colville, George J. (C)
Loper, D. R. (B)
Spiva, Donald J. (C)

SANGAMON VALLEY

Mello, Francis R. (C)

SHREVEPORT

Gelfand, Meyer (C)
LaPlaca, C. A. (C)

STARK CENTRAL

Willmott, J. C. (C)

WASHINGTON, D. C.

Campbell, Joel M. (C)
Olcott, Eugene L. (B)
Pritchard, James R. (C)

WESTERN MASSACHUSETTS

Silver, Gordon H. (B)

WESTERN MICHIGAN

DeWall, Eric (C)

WORCESTER

Mohler, William R. (C)

NOT IN SECTION

Addyman, Stanley A. (B)
Christy, Benjamin (C)
Cox, Philip J. (C)
Fearon, F. L. (B)
Herrick, George C. (C)
Manter, Donald I. (B)
Morrison, E. H. (C)
Rodier, Paul R. (C)
Tuttle, Robert S. (B)
White, Robert L. (B)
Wilson, George G. (B)

Members Reclassified

During the Month of August

IOWA

Kelleher, Patrick (C to B)

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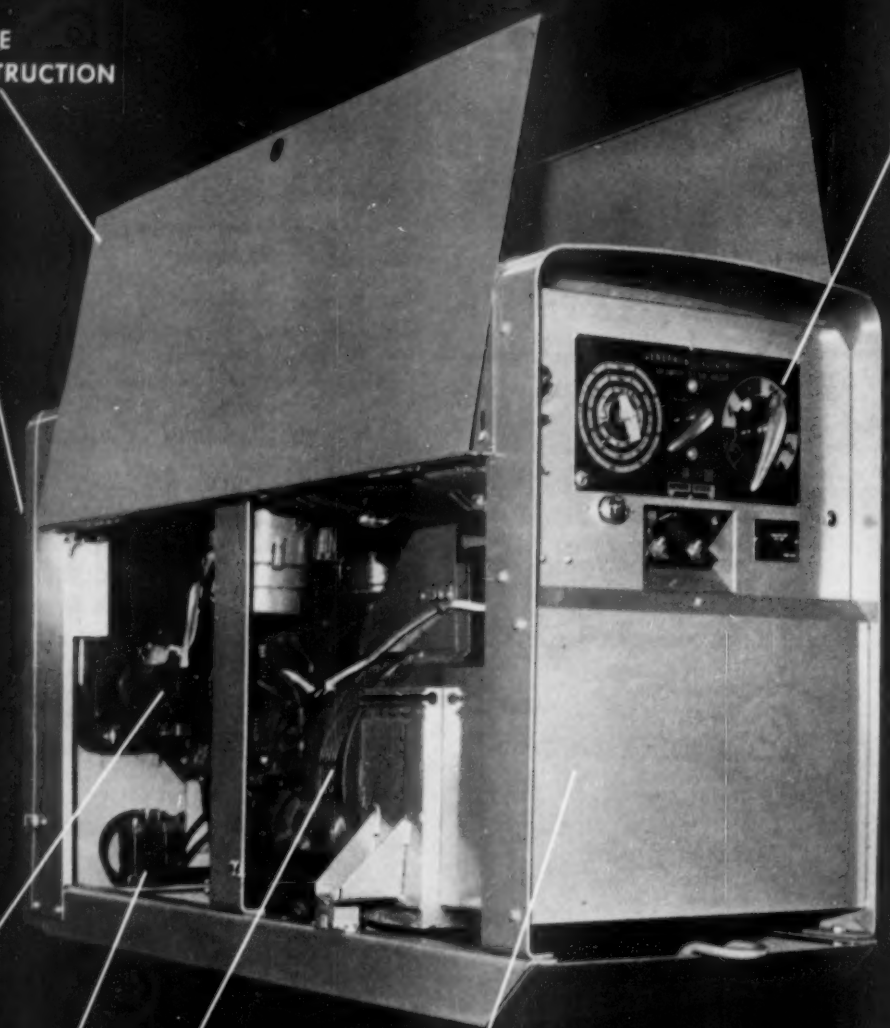

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EASILY PRESET Electrode Selector, Current Dial—Dual Controls make current setting easier and more accurate.

GENERAL ELECTRIC	✓	
MANUFACTURER A		
MANUFACTURER B		

How General Electric's NEW Line of Engine-driven Welders Help You Save with Faster Welding

Advanced design assures less "downtime," minimum maintenance—for faster, lower-cost welding

Nothing stretches out welding time more than unreliable or obsolete equipment. Such equipment increases your maintenance costs and results in nonproductive "downtime."

To reduce welding delays, General Electric's new line of engine-driven welders has been designed and field-tested for maximum durability and minimum maintenance—without sacrifice in performance. These new 200-, 300-, and 400-amp welders save for you with the following advantages:

SAVE YOU TIME—Sturdy construction, the dependable Hercules engine, new-design generator, and simplified control all combine to give you steady output, longer operating time between overhauls, and reduced maintenance. This means more production per machine . . . per man-hour.

SAVE YOU MONEY—General Electric engine-driven welders begin saving you money the first day on the job. For example, the deep-sump crankcase provides complete lubrication to all moving engine parts—up to a 15-degree tilt in any direction. This helps to reduce costly breakdowns. And the over-all advanced design assures you of more and better welds at less cost, with a reduction in costly downtime for maintenance and repair. Additional General Electric advantages are described below.

For more information about how General Electric engine-driven welders can help you, contact your nearby General Electric Welding Distributor. He is listed in the yellow pages of your telephone book. Write for descriptive bulletin to Section 714-5A, General Electric Company, Schenectady 5, New York.

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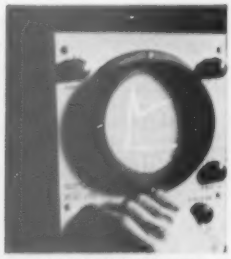

CONTROLLED CURRENT Peaks—Current peaks are controlled. Arc can be crowded with no "stumbling" or "freezing."

	✓	✓	✓	✓	✓
		✓	✓	✓	
				✓	

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For copies of articles, write directly to publications in which they appear

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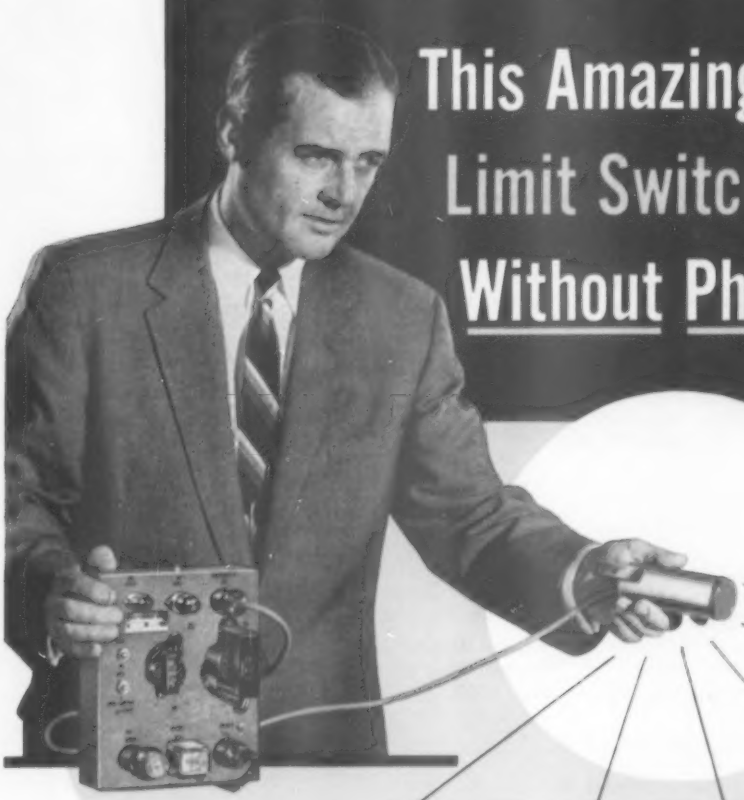

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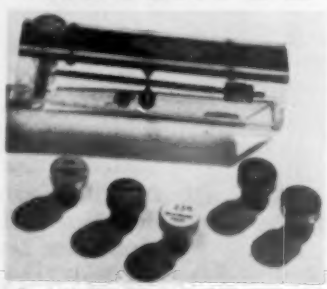

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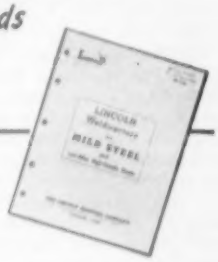

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ABSTRACTS OF CURRENT PATENTS

prepared by Vern L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington, D. C.

2,755,476—Spark Deflector/Visor Assembly—Charles Evans Bowers, Sr., Moylan, Pa., assignor to The Fibre Metal Products Co., Chester, Pa., a corporation of Pennsylvania.

This patented spark deflector assembly has the usual head engaging band or means therein, and it has a pivotally positioned plastic visor as well as a spark deflector element. Means are provided for locking the deflector and plastic visor in operative positions.

2,755,542—Method of Providing Brazed Ferrous Metal Parts with Aluminum Coating—Alfred L. Boegehold, Detroit, Mich., assignor to General Motors Corp., Detroit, Mich., a corporation of Delaware.

Boegehold's new process relates to the formation of a structure highly resistant to oxidization at an elevated temperature. The process consists of copper brazing together a plurality of ferrous metal parts and then preheating the assembly to a temperature at least as high as the melting point of aluminum while immersed in a special salt bath. Then the heated assembly is immersed in a molten aluminum bath to obtain an aluminum coating joined both to the ferrous metal and exposed copper brazing material by an alloy bond of specified thickness.

2,756,308—Electric Welder—Raymond E. Powell, Westfield, N. J., assignor to Western Electric Co., Inc., New York, N. Y., a corporation of New York.

This patent relates to an attachment for welding apparatus which has a fixed electrode and a movable electrode actuated by a spring. The attachment itself comprises means for overcoming any irregularities in the engaging surfaces of the materials and including a force applying unit for applying its force to the movable electrode. Other means are provided for rendering the unit ineffective after the irregularities have been overcome so that the final movements of the movable electrode are under the force of the control spring.

2,756,309—Apparatus and Methods for Welding Electric Cable Sheaths—James Arthur Donelan, West Harrow, England, assignor to Pirelli-General Cable Works Ltd., London, England, a British company.

This apparatus relates to forming a metal strip to constitute a sheath around at least one electric cable core and it has means for progressively bringing the edges of the strip into juxtaposition around a cable core and a welding torch is provided for welding the edges of the strip together along the seam. The torch has a normal stationary welding position and means are provided for moving the formed strip and the enclosed cable core past said torch. Apparatus also is provided for mounting the torch for movement parallel to the seam prior to starting the torch from its normal stationary position and after starting of the torch back to the normal stationary position by moving the torch in a direction opposite to the movement of the strip and cable.

2,756,310—Welding Rod Holder—John F. Galbraith, Plainfield, N. J., assignor to Union Carbide and Carbon Corp., a corporation of New York.

Galbraith's patented welding rod holder includes a tubular body of conductive metal through which a welding rod may be moved and supplied with current therefrom. One end of the tubular body is slotted to provide resilient cantilever arms with wear resisting conductive inserts on the outer ends thereof. These arms are adapted to exert a clamping action on a welding rod. Other means lock the arms in desired operative position.

2,756,311—High-Speed Tandem Arc Working—John A. Persson, Kenmore, and Jan M. Ruzek, Niagara Falls, N. Y., assignors to Union Carbide and Carbon Corp., a corporation of New York.

This new process comprises relatively moving metal work to be welded at a speed approximately of 360 ipm and more with relation to an arc-welding station containing at least two gas-shielded fusible and refractory electrode-arcs in tandem. The work is welded with a leading arc so that the resulting preliminary weld is fully penetrated but undercut, and shaping the weld by melting the metal thereof with a trailing arc so that the undercutting is removed and the final weld is smooth and sound.

2,756,312—Method of Forming Door Panels—Michael Watter, Philadelphia, Pa., assignor to The Budd Co., Philadelphia, Pa., a corporation of Pennsylvania.

This patent is on a method of spot welding a structure comprising an outer panel and a web. The outer panel and the web are positioned so that they extend transversely of each other and with the flange and outer leg overlapping. The flange is engaged by one welding electrode and the inner leg by a second welding electrode. Welding pressure is applied by the electrode and welding current passes to effect a spot weld between the flange and outer leg.

2,756,492—Manufacture of Composite Ductile Wire—Robert L. Pettibone, Detroit, Mich., assignor to Eaton Manufacturing Co., Cleveland, Ohio, a corporation of Ohio.

This patent is on a method of making a composite ductile wire for welding use so as to produce a hard facing. The method comprises inserting a plurality of substantially equal diameter in length cylindrical slugs of a powder or granule metallic composition of an analysis which when alloyed with the tube forms a nonductile body. The tube used is of a predetermined size, wall thickness and composition to provide the desired effect. Then the slugs of metallic material are suitably secured in the tube and it is worked to a final desired size.

2,757,269—Process for Brazing—Dean K. Hanink, Birmingham, and Robert F. Thomson, Grosse Pointe Woods, Mich., assignors to General Motors Corp., Detroit, Mich., a corporation of Delaware.

This patented brazing method relates to the steps of coating the metal surfaces to be joined with a viscous mixture of a powdered metallic brazing material and an organic vehicle, and then pressing the coated surfaces together with a pressure of at least 1000 lb per sq in. Sufficient electric current is applied through the junction of the two surfaces to cause the organic vehicle to be rapidly driven off in the form of gaseous substances to form a protective blanket around the brazing material and prevent oxidation of such material while also fusing the brazing material.

2,757,296—Combination A-C and D-C Welder—Harry J. Bichsel, East Aurora, N. Y., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

This patent covers the combination of a transformer having a primary, a first secondary and a second secondary, and a pair of load terminals. Main rectifier means having input and output connections are provided while auxiliary

rectifier means having input and output connections are present in the circuit. Means connect the second secondary across the input connections of the auxiliary rectifier means while other circuit means connect the output connections of the auxiliary rectifier means to the output connections of the main rectifier means. The potentials impressed upon the output connections of the main rectifier means by both of the said rectifier means are of the same polarity. Other means selectively connect the first secondary directly to the load terminals or the said output connections to the load terminals and the first secondary to the input connections of the main rectifier means.

2,758,184—Spacer Bar and Die Cleaner Mechanism for Strip Welder—Melvin M. Seeloff and Robert Anderson, Warren, Ohio, assignors to The Taylor-Winfield Corp., Warren, Ohio, a corporation of Ohio.

This patent relates to a flash-butt welding machine having a fixed and a movable platen and having relatively movable dies carried by each of the platens for clamping workpieces to be welded. The patent relates to the provision of a spacer bar adapted to be inserted between the platens for spacing the end edges of pieces to be welded together. The platens are moved into a predetermined separated position prior to insertion between the platens of the spacer bar which has gaging means thereon. Other means withdraw the movable platen a predetermined distance following a gaging operation to increase the spacing between the platens. Other means are operative after the movable platen has been withdrawn and cause the spacer bar to move outwardly of the fixed platen a distance less than the movable platen is withdrawn so that parallel gaging faces on the spacer bar are clear of strip end portions gripped by the platen when the spacer bar is withdrawn.

2,758,185—Welding Rod Holder—Harold B. Bergeson, Wilmington, Ill.

This patented welding electrode holder includes elongated sleeve means for engaging an electrode and including an elongated plunger so that the sleeve and plunger means can be moved longitudinally in the holder for movement to and from electrode clamping positions.

2,758,186—Deep Penetration Gas Shielded-Arc-Welding Process—Howard C. Ludwig, Pittsburgh, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania.

This patent relates to a method of arc welding work comprising impressing a potential to produce an arc between the electrode and the work and projecting an inner stream of oxygen along the electrode. A shielding stream of an inert gas is also projected around the electrode and this inner oxygen stream.

2,758,307—Face Shield—Kenneth L. Treiber, Alexandria, Va.

This patent covers a specialized type of a head and face-shield assembly such as can be used by a welder or equivalent workman.

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Today, Higgins builds one of these platforms in about 60 days. The amount of welding involved approaches the fantastic. To make these tough-service welds, they're using A. O. Smith SW-10 (E-6010) . . . SW-15 (E-6013) . . . and SW-44 (E-6024) electrodes and A. O. Smith welding machines.

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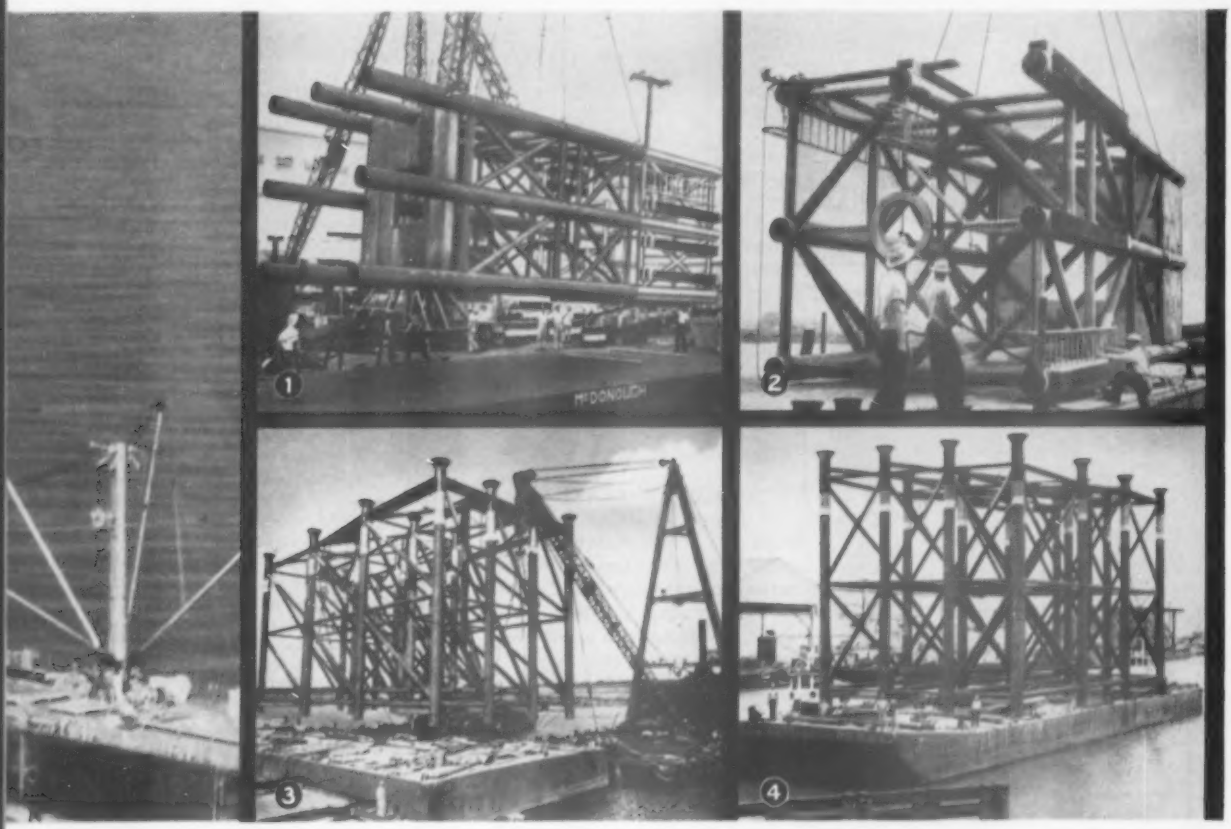

To tap black gold beneath the sea, oil drilling rigs like this are located anywhere from a few hundred yards up to 150 miles offshore. Upon the strength of these structures rests the lives of scores of men, millions of dollars. What better testimonial for the dependability of welds made with A. O. Smith electrodes.

1 Platforms, fabricated on dry land, are begun by welding 10 or 12 foot sections into longer columns. Shiny sections at right are special treated sections of structure that resist corrosion at the splash zone.

2 A completed single well protector jacket being loaded for delivery to its offshore location.

3 Huge cranes, capable of handling 250-ton loads are used to load completed assemblies onto sea-going barge. The barge delivers them to the offshore drilling site and a ship's crane sets them in place.

4 Object of pre-fabricating assemblies and shipping them by barge, like this, is to cut production costs, also to minimize danger relative to length of time incompleted platform must survive.

2,759,082—Method of Heading a Hollow Rivet—Stanley E. Rea, Redondo Beach, Calif., assignor to Northrop Aircraft, Inc., Hawthorne, Calif., a corporation of California.

This patented method of heading the unheaded end of a hollow metal rivet includes the steps of inserting a metal mandrel into the hollow of the rivet and making electrical contact between the mandrel and the unheaded end of the rivet by means of mechanical interference between these parts. An electrical heating current is passed through the mandrel into the unheaded end of the rivet through the contact area to soften such unheaded end and the mandrel is moved longitudinally of the rivet against the interference to effect the formation of the unheaded rivet end while hot. A continued electrical current of greater effect is passed through the contact area to weld the metal mandrel in place.

2,759,083—Apparatus for Applying Hard-Facing Metals—Kenneth E. Richter, Morristown, and Lloyd W. Young, Elizabeth, N. J., assignors to Union Carbide and Carbon Corp., a corporation of New York.

This patented apparatus for hard-facing a metal workpiece to form a wear-resistant surface thereon comprises means for striking an arc on the workpiece and provide a weld puddle thereon while other means are present for shielding the arc and weld puddle with a stream of gas. A stream of hard-facing particles are projected through the shielding gas into the weld puddle and other means progressively move the arc, weld puddle, shielding gas and stream of hard-facing particles along a line of weld on the metal workpiece. Other means oscillate the stream of hard-facing particles transversely with respect to the line of weld to distribute these particles uniformly throughout the weld puddle.

2,759,084—Welding Composition for Depositing Soft Iron—Clarence E. Jackson and Arthur E. Shrubsall, Niagara Falls, N. Y., assignors to Union Carbide and Carbon Corp., a corporation of New York.

The present patent is on an electric welding process of the submerged arc type and wherein a blanket of comminuted welding medium covers the welding region and a carbon steel welding electrode is immersed in the welding medium. The improved process of this patent comprises refining the welding electrode of substantially all of its carbon content and other impurities to produce a weld deposit of substantially soft, elemental iron. The invention also includes the provision of readily reducible oxides in the welding medium and with such medium being composed of from about 4 to 32% lime, 40 to 75% iron oxide, up to 25% alumina and up to 25% calcium fluoride.

2,759,120—Welding Head Control Apparatus in Systems Using Separately Excited D-C Welding Generators—Elliott C. Cornell, Jr., Cleveland, Ohio, assignor to The Auto Arc-Weld Manufacturing Co., Cleveland, Ohio, a corporation of Ohio.

This patent relates to automatic welding control apparatus for use with a welding system having a field winding and separate excitation means for such winding. The invention also includes the provision of suitable means for feeding an electrode to a weld and including a pair of motors for feeding the electrode in opposite directions. Another member is provided for connection to the welding generator and controlled by the voltage thereof for connecting a resistance in the circuit of one of the motors before a weld arc is struck to slow such motor down, which motor moves the electrode toward the work. Time-delay means are also provided for closing the operating circuits of the motors a predetermined and controllable interval after the apparatus has been actuated to start the motors in delayed relation to the closing of the energization circuit for the generator field.

2,759,246—Method of Making Hollow Articles—Huntly M. Campbell, Alton, Ill., assignor to Olin Mathieson Chemical Corp., East Alton, Ill., a corporation of Virginia.

This method relates to the manufacture of hollow articles from sheet metal and includes the step of coating a metal sheet with stop-weld. Thereafter lateral margins of the metal sheet are folded over to lie adjacent to a pair of opposite edges of the sheet to form a second layer of metal which only partially overlaps the sheet and has the stop-weld sandwiched between such first sheet and a second sheet positioned thereover. The assembly is hot rolled to elongate it and forge weld the laps of the folded sheet to the second sheet and to reduce the assembly in thickness until it is substantially uniform throughout and the unwelded surfaces having stop-weld therebetween are substantially in contact with each other.

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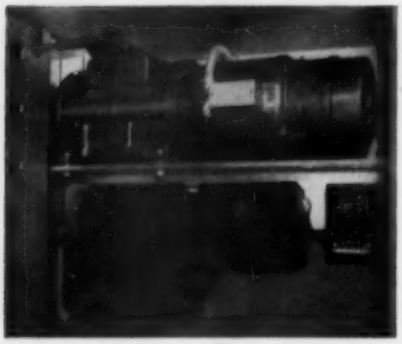

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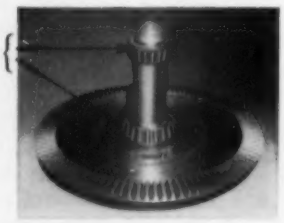

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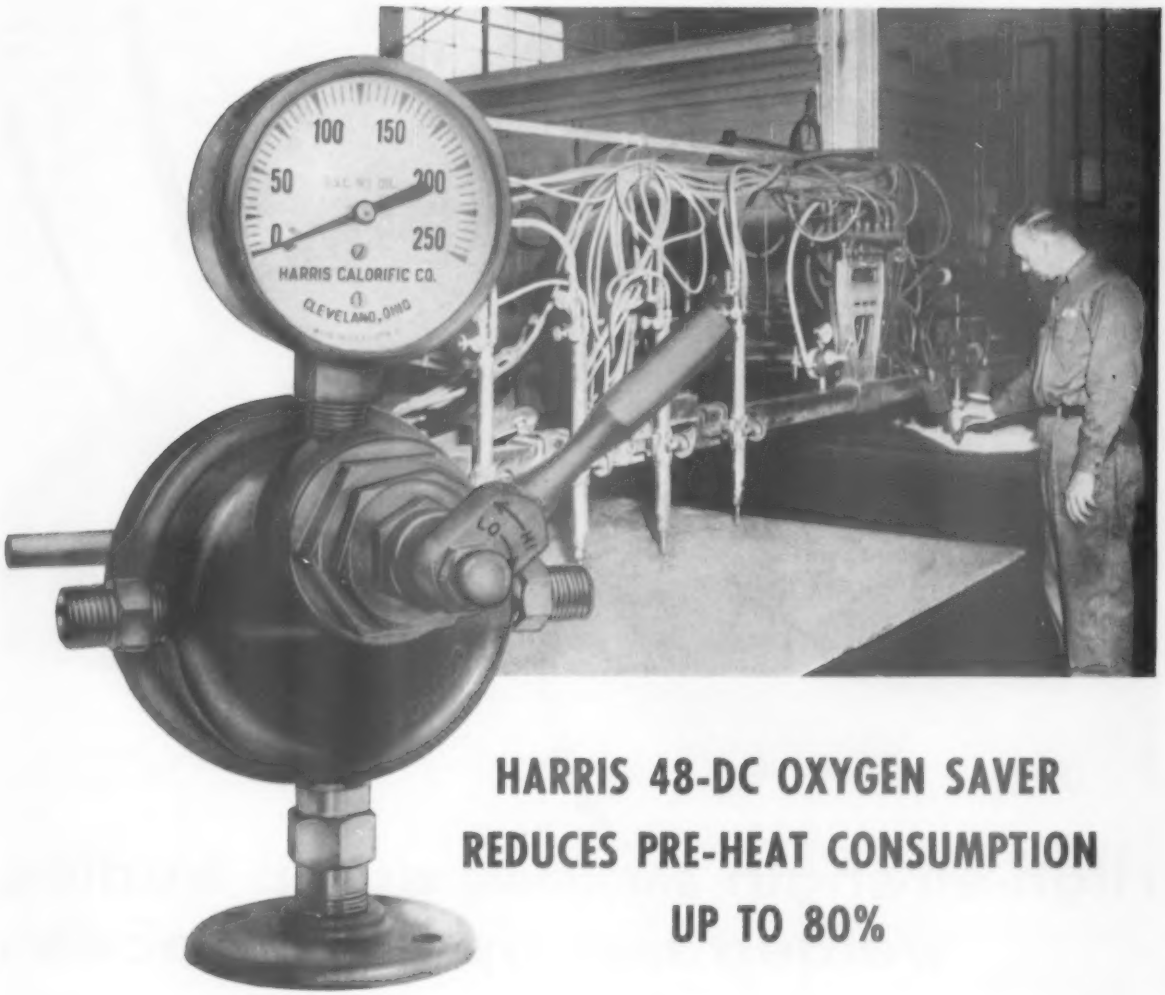

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For some time, dump truck operators have cast longing eyes at the light weight and high payloads that aluminum dump bodies would make possible. But nobody knew how to weld aluminum bodies strong enough or fast enough.

But recently two important things happened: the shielded arc, inert gas, consumable-electrode method was developed and improvements were made in Alcoa Alloy 5154. Used with the new welding techniques, alloy 5154 now provides a 25% increase in strength across welds and a 150% increase in ductility.

Speed is way up, too. Penn Body Division of Hockensmith Corporation, a leading dump body builder, butt welds $\frac{3}{16}$ inch sheet at speeds up to 30 inches per minute, compared with 16 inches per minute for the tungsten arc process. Depending on conditions and equipment, speeds as high as 60 to 80 inches per minute are now possible.

Now, companies like Penn Body offer a complete line of dump bodies that weigh only half as much as steel but with equivalent, or better, stiffness and impact resistance.

To make the bodies, Penn Body first butt-welds the floor from two sheets of 5154 alloy. Cross bracing is then added by skip-welding extruded beams of 6061-T6 alloy. Longitudinal members are welded in position and the sides and front, press braked from 5154 sheets, are welded in place.

Alcoa is headquarters for fresh, exciting ideas on how to weld, braze or solder aluminum. Get in touch with us. Where? See information at right.

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Pacific Metals Company, Ltd.
COLORADO
Denver
Metal Goods Corp.
CONNECTICUT
Milford
Edgcomb Steel of New England, Inc.
FLORIDA
Jacksonville
Florida Metals, Inc.
Miami
Florida Metals, Inc.
Tampa
Florida Metals, Inc.
GEORGIA
Atlanta
J. M. Tull Metal & Supply Co., Inc.
Southern Oxygen Co.
IDAHO
Boise
Pacific Metal Co.
ILLINOIS
Chicago
Machinery & Welder Corp.
Steel Sales Corp.
Moline
Machinery & Welder Corp.
KENTUCKY
Louisville
Williams & Co., Inc.
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Whitehead Metal Products Co., Inc.
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NEW YORK
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OKLAHOMA
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Metal Goods Corp.
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WASHINGTON, D. C.
Southern Oxygen Co.
WISCONSIN
Milwaukee
Machinery & Welder Corp.

Thereafter the unwelded areas between the sheets are expanded with fluid pressure.

2,759,249—Welding Dissimilar Metal Members with Welded Joint, Including Stabilized Ferritic Metal Zone—Fritz T. Eberle, Barberton, Ohio, assignor to The Babcock & Wilcox Co., Rockleigh, N. J., a corporation of New Jersey.

This patent relates to a method of joining a ferritic alloy member of a specified composition to an austenitic alloy member of a slightly different but specified composition. This method comprises disposing a stabilized ferritic steel alloy insert between the members, joining the insert to the ferritic member by fusion depositing ferritic alloy steel of substantially the same composition as the alloy member and joining the insert to the austenitic member by fusion depositing austenitic alloy steel of substantially the same composition as the austenitic alloy member.

2,759,446—Brazing Mixture—Charles W. Ewing, Centerville, Ohio, assignor to General Motors Corp., Dayton, Ohio, a corporation of Delaware.

This patent to Ewing is upon a non-caking readily stored dry copper brazing powder mixture capable of being quickly mixed with water on the job in small amounts to make a copper brazing paste capable of retaining its water solubility upon drying. The mixture primarily comprises copper powder with small amounts of alkali carboxymethyl cellulose and iron oxide powder therein.

2,760,041—Spot Welding Apparatus—William A. Yonkers, Mountain Lakes, N. J., assignor to Radio Frequency Laboratories, Inc., Boonton, N. J., a corporation of New Jersey.

Yonker's patent is on a spot-welding gun including a housing carrying a transformer having a multiturn primary winding on one core leg and a single-turn, flexible secondary coil on the opposite core leg. The secondary coil terminates in a pair of normally spaced, cooperating electrodes extending outwardly of the housing. Lever means are provided in the apparatus for engaging the outer surface of the secondary coil and flexing it to reduce the spacing between the electrodes.

2,760,042—Apparatus and Methods for Welding Metal Tubes—James Arthur Donelan, West Harrow, England, assignor to The General Electric Co., Ltd., London, England.

This patented machine is for making metallic tube from strip material by bending the strip progressively to form an open tube with butting edges and electric arc welding the seam formed by the butting edges to form a closed tube. The welding apparatus includes a welding torch, a movable carriage for the torch and having a normal stationary welding position and at least one position displaced from such normal welding position in the direction of movement of butting edges of the tube past the welding torch. Other means are provided and are operative upon starting or restarting of the torch for moving it

Who's Who?

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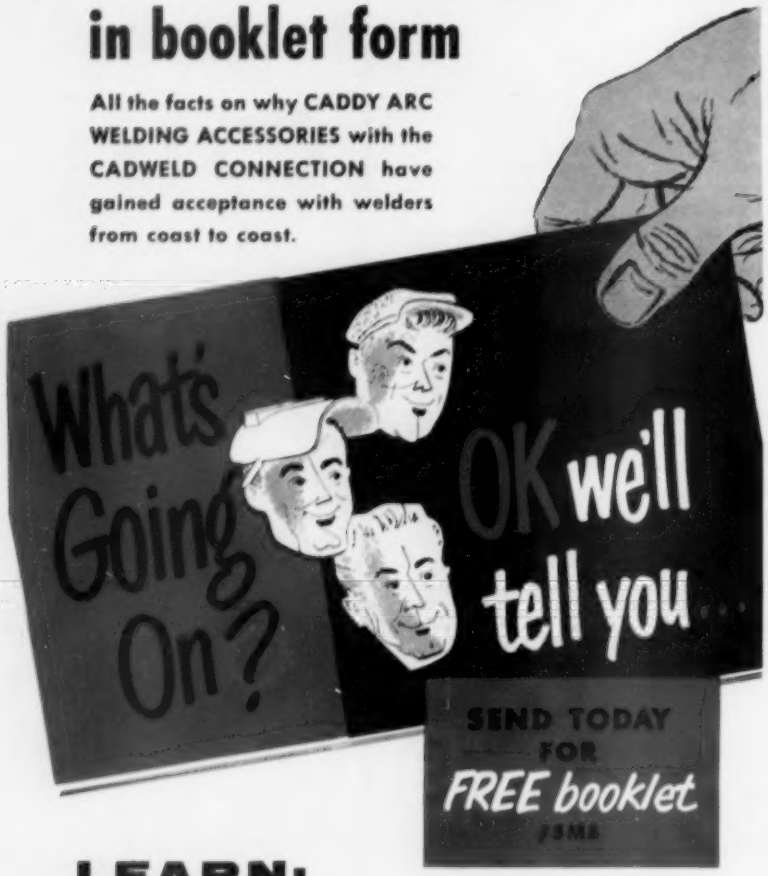

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back to its normal stationary welding position at a desired uniform speed.

2,760,043—Welding Machine—Joseph D. Christian, San Francisco, Calif.

Christian's patent is on a welding apparatus for welding hollow screw flights. The apparatus includes a base, a frame tiltably mounted on the base, and means for tilting the frame to a required angle. A rotating work holder is mounted on the frame and means are provided for rotating the work holder. A welding carriage is slidably mounted on the frame for sliding parallel to the axis of the screw flight, molten flux carrying means are provided and other means position an electrode to dip into this flux. These last members are positioned to float in unison according to variations in the parts being welded.

2,760,044—Method of Arc Welding—Chester D. Mott, Evanston, Ill., assignor to Fansteel Metallurgical Corp. a corporation of New York.

This patent is on a method of welding members of a refractory metal and it comprises supporting the metal members at regions sufficiently remote from the edges thereof to be welded so that the portions to be heated above the temperature at which the metal is susceptible to contamination from solids are free from contact with solids during welding. All metal surfaces hot enough to be susceptible to contamination from gases during the heating and welding action are enveloped in an inert atmosphere. A self-supporting molten pool is formed during weld conditions by the electric arc, and an inert gas is introduced into the weld region during welding from points above and below the metal portion being welded. The velocity of flow of this inert gas prevents both chilling of the molten pool and ingress of air while washing away from the heated surfaces any oxidizing gases formed during welding.

2,760,145—Arc-Welding Transformer Apparatus—Ulysses S. Dunn, Chicago, Ill.

This patent relates to an arc-welding transformer having a core, a primary winding and a secondary winding for delivering regulated alternating current suitable for welding. Means control the welding current delivered by such secondary winding and comprise a magnetic shunt disposed between the primary and secondary windings, and a winding closely coupled to the primary winding and having a voltage substantially equal to the open circuit voltage of the secondary winding is connected in voltage opposition to such secondary winding. A rectifier is energized by the secondary winding and the closely coupled winding. D-c magnetization varying inversely according to the voltage of the secondary winding is applied to the magnetic shunt.

PERSONNEL

Slinger and Doty Appointed

Crucible Steel Co. announces the appointment of Walter Slinger and Benjamin F. Doty as welding engineers with headquarters at Crucible's New York Branch, Harrison, N. J.

Mr. Slinger has been associated with Crucible Steel for over 25 years as a welding supervisor at the Spaulding Works, Harrison, N. J. In that capacity, he has been active in the company's welding development and research program. He has been actively engaged in conducting numerous welding clinics throughout the country.

Mr. Doty comes to Crucible with more than 20 years experience in the welding field. During that time he has been a vocational instructor and served as superintendent in charge of stainless steel fabrication for products used in the chemical, food, textile, and aircraft industries.

Isenburger Appointed by Governor Meyner

Governor Robert B. Meyner of New Jersey has created a special Advisory Committee on Radiation Protection and has appointed Herbert R. Isenburger, president of St. John X-Ray Laboratory, Califon, N. J., and a long-time member of the AWS, to serve as a member. The Committee just submitted a draft of a Radiation Protection Act to the Governor and is presently working on the final draft of a State Code. This Code will not only effect hospitals but also industrial establishments where radiation sources and radiation emitting equipment are in use. Since there are quite a number of such installations in welding shops throughout the State, this matter should be of importance to all those concerned. As soon as the Code is available in its final form, open hearings will be held in various parts of the State.

Cleeves Promoted by G. E.

John B. Cleeves has been appointed manager of finance for the General Electric Co.'s Welding Department. He succeeds Elton A. Turner who has been named manager of finance for the company's Metallurgical Products Department.

A native of New York, N. Y., Mr. Cleeves was graduated from Lehigh University in 1937 with a degree in business administration and joined the General Electric Company that same year on its business training course. After various assignments in several company departments, he was appointed manager of general and tax accounting of the Instrument Department in 1955, the position he has held until the present time.

Masters Made Welding Engineer

The appointment of Paul E. Masters as welding engineer of U. S. Steel's American Bridge Division was announced today by C. S. Shepherd, chief engineer, facilities and specialties.

Paul E. Masters

Mr. Masters, a native of Joliet, Ill., graduated from Iowa State College with a B.S. degree in engineering. He furthered his education at Carnegie Institute of Technology and the University of Pittsburgh.

Mr. Masters began his career with American Bridge in 1942 as a draftsman in the mechanical engineering department. In 1943 he was made assistant to welding engineer, and in 1955 was promoted to engineer of tests of American Bridge Division. In 1956 he was promoted to senior project engineer, facility and specialty engineering department of the American Bridge Division, the position he held until his recent appointment.

In his new position Mr. Masters will be responsible for all engineering services pertaining to welding technology, practices and facilities.

Mr. Masters is a member of the American Welding Society.

Appointed Assistant Editor

Dave Ritchie, former welding sales engineer with Lincoln Electric and A. O. Smith Corp., has been appointed assistant editor of *Metal Progress*, national engineering journal, published in Cleveland, Ohio, by the American Society for Metals.

Mr. Ritchie is a native of Canada and received his high school education in Saint John, New Brunswick. In 1945 he entered the University of New Brunswick, receiving his Bachelor degree in 1949. In the fall of 1949, he entered Western Reserve University in Cleveland, Ohio graduating with a degree in business administration.

Following his welding sales experience Mr. Ritchie returned to Cleveland early in 1955 as associate editor of "Industry and Welding" and "Welding Illustrated."

Mr. Ritchie is a member of the American Welding Society.

New Posts for Stewart and Swan

John T. Stewart and Charles H. Swan have been appointed to the newly created positions of welding product manager and assistant welding product manager of Whitehead Metal Products Co., Inc.

John T. Stewart

Mr. Stewart, in his 31st year with Whitehead, specialized for the last 11 years in the sales and technical area of welding products and acted as manager of the Welding Department. He is the current 1956–57 chairman of the New York Section of the American Welding Society.

AIRCO

WELDING and BRAZING *Hints*

PROBLEM:

To weld cast iron

SOLUTION:

Airco #9 Cast Iron (square). This is a high quality, grey cast iron welding rod commonly used for oxyacetylene welding of cast iron. It assures easy weldability and will produce soft machinable deposits when used with correct pre- and post-heating procedures.

Airco #10 Moly-Cast Iron (square). Deposits obtained with this rod are stronger than those from standard cast iron rods. Recommended for welding alloy cast iron and for building-up worn areas on diesel engine cylinder heads. This rod may be used for welding alloy cast iron of the same or different analysis providing the base metal does not contain ingredients to produce some special characteristic such as corrosion resistance.

Atlas Cast Iron Welding Flux. This flux has a lower specific gravity than cast iron, thus floats out the oxides and impurities to assure sound cast iron weld metal. To expedite the job, sprinkle some of this flux over the joint and the molten puddle.

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You'll find here the finest rods and fluxes for joining both ferrous and non-ferrous metals. Write Airco at address below.

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Mr. Swan, who started with the company in 1934, receives the appointment as assistant welding product manager to complement Mr. Stewart's activities. Mr. Swan, formerly in charge of silver brazing operations in the New York Metropolitan area, is having his duties expanded to include welding activities of the company.

Iverson Appointed

Alloy Rods Co., York, Pa., has announced recently the appointment of Einar Iverson to the company sales staff.

Iverson is a graduate of Rensselaer Polytechnic Institute, with a B.S. in

Einar Iverson

welding metallurgy. He has served in the capacity of welding engineer for some of the nation's leading steel fabricators. Iverson will work with Alloy Rods Co. distributors in the company's Midwestern States territory.

Fitzsimmons Made Field Representative

The Stoody Co. of Whittier, Calif., announces that it has added L. P. Fitzsimmons to its staff of field representatives. He will cover Virginia, North and South Carolina, Georgia, Alabama and Florida.

Mr. Fitzsimmons is a native of New Orleans and attended Louisiana State University. He has a background of 18 years in welding.

Simms Named Field Representative

Jackson Products, Inc., Warren, Mich., has announced that Howard N. Simms will take over the Southwestern territory as field representative with headquarters in Oklahoma City.

Mr. Simms was formerly manager of Quality Control, Oil & Gas Division of Black, Sivalls & Bryson, Inc., Oklahoma

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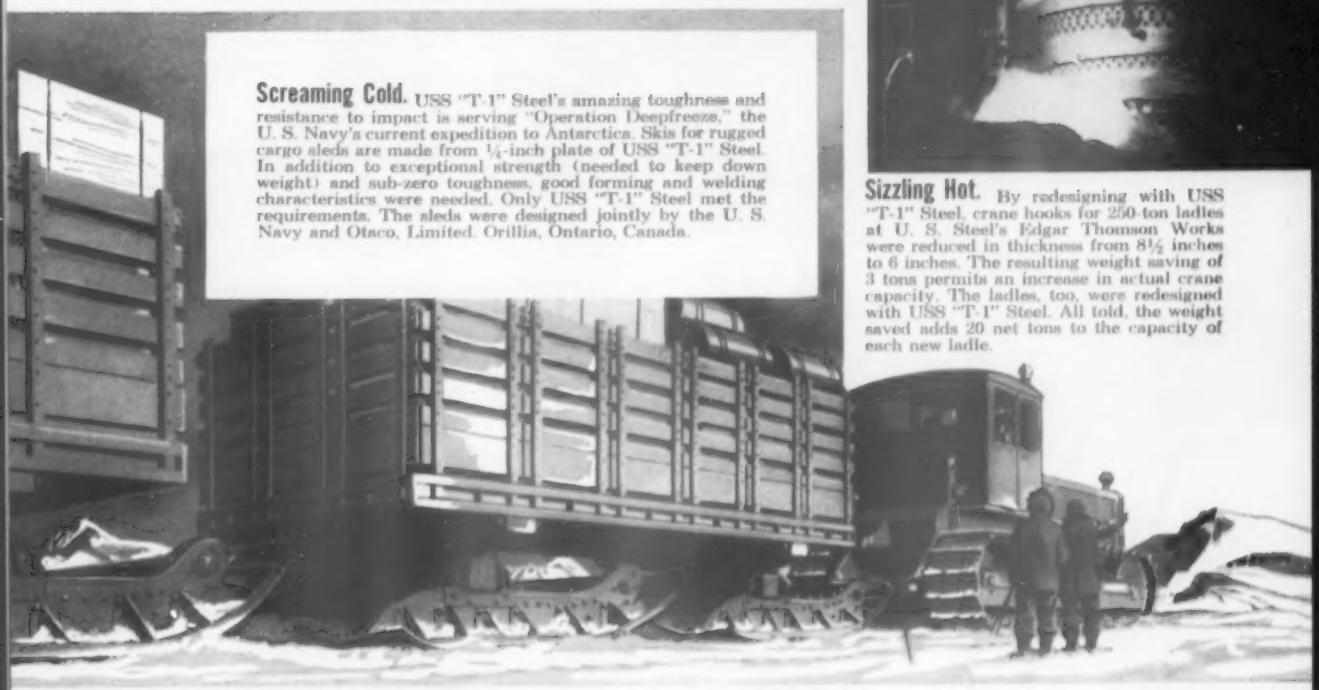

Screaming Cold. USS "T-1" Steel's amazing toughness and resistance to impact is serving "Operation Deepfreeze," the U. S. Navy's current expedition to Antarctica. Skis for rugged cargo sleds are made from ¼-inch plate of USS "T-1" Steel. In addition to exceptional strength (needed to keep down weight) and sub-zero toughness, good forming and welding characteristics were needed. Only USS "T-1" Steel met the requirements. The sleds were designed jointly by the U. S. Navy and Otaco, Limited, Orillia, Ontario, Canada.

28 Million Pounds of wet, abrasive coal are handled each day at this steam-electric generating station. And USS "T-1" Steel is being used at points of severe wear in coal chutes and hoppers, pulverizer feed pipes and exhaust pipes, and for liners of ash collectors. USS "T-1" Steel's durability under impact and impact abrasion, its great tensile strength and its good weldability are often essential in rugged coal handling equipment. USS "T-1" Steel can add service life and cut repair and maintenance costs in many types of heavy-duty equipment.

Repair Reduces Downtime. In this coal stripping operation, time costs more than any other item; and *lost* time, caused by breakage and wear of power shovel parts, was costing far too much. So the owner, Putnam & Greene, Inc., Philipsburg, Pennsylvania, started using USS "T-1" Steel for repair work. As a result, size and weight of parts have been reduced, while durability has been improved substantially. What's more, USS "T-1" Steel's good weldability speeds repair work.

How It Can Help You

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking heavy impact and abuse at sub-zero temperatures. Its excellent weldability can help you cut the cost of fabricating highly stressed parts, and to reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Room 5439, Pittsburgh 30, Pa.

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Take the difficulties out of difficult metals. Join cast iron, bronze, brass, copper, galvanized iron, and malleable iron, or any one of these to another.

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City and is well known for his extensive knowledge of all types of welding procedures and metallurgical research. Mr. Simms is also a member of the AMERICAN WELDING SOCIETY, Society for Testing Materials and Society for Metals.

As past district vice-president and director of the AMERICAN WELDING SOCIETY, Mr. Simms is widely known and, because of his unceasing efforts in that direction, was a recipient of the AWS District Meritorious Award.

OBITUARY

Russell C. Mahon

Russell C. Mahon, founder and chairman of the board of the R. C. Mahon Co., died suddenly at his home in Detroit on March 30th. Mr. Mahon was born in Columbus, Ohio, in 1890, and moved to Detroit as a child with his parents.

The large multidivision company bearing his name was started by Mr. Mahon as a small roofing business in 1912 at Detroit. In 1919 he started producing metal-clad fire doors. In 1921 an industrial sheet metal department was formed to take care of the growing needs of the automobile industry for exhaust, ventilation and paint finishing equipment. About this time, Mr. Mahon acquired a corporation known as the Detroit Steel and Conveyor Co. In 1925, the name of this company was changed to the Mahon Structural Steel Co. and it later was brought into the parent company as the Structural Steel Division.

Today the company is comprised of eight divisions. It employs 3000 people.

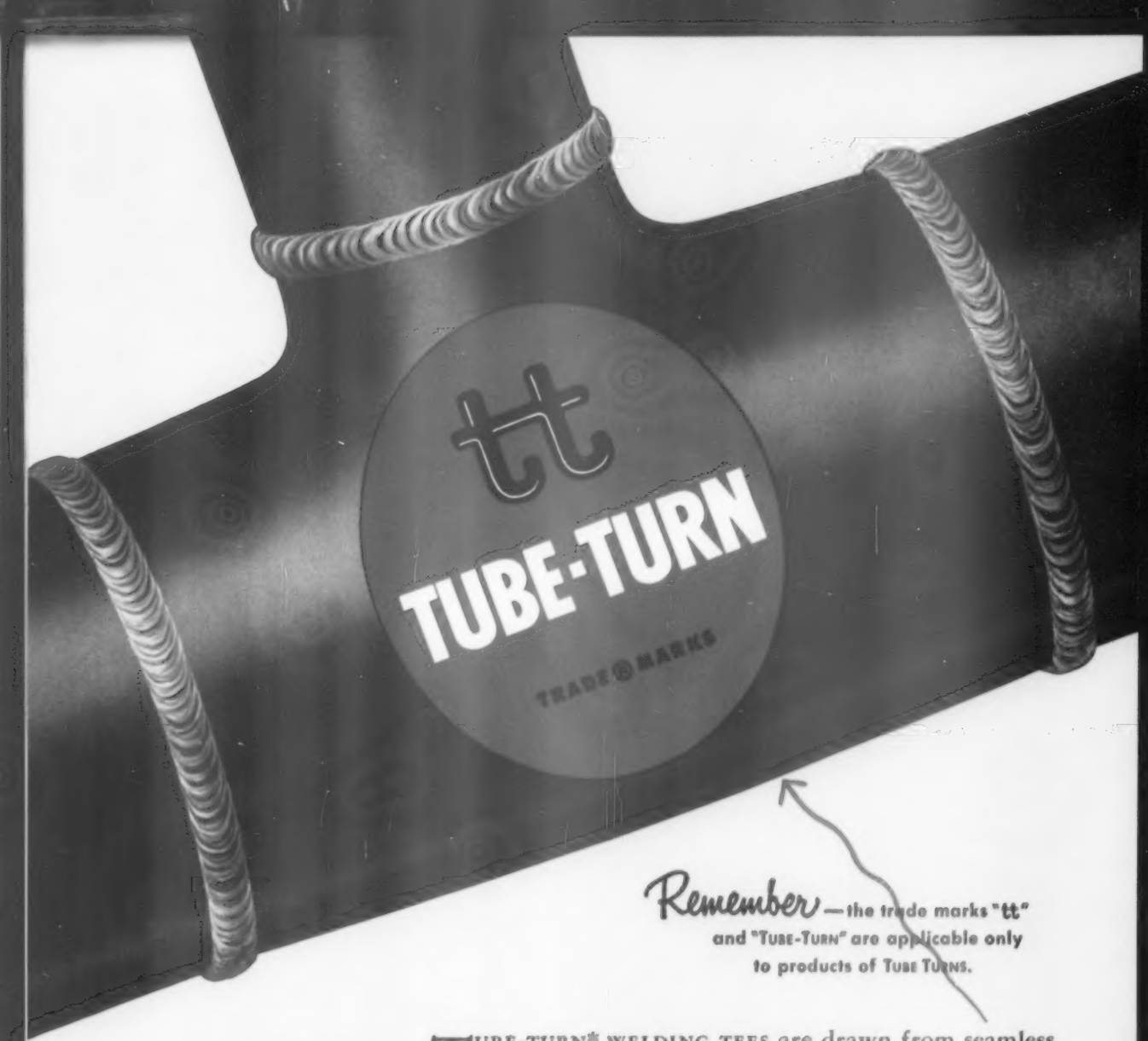
Mr. Mahon was AWS Sustaining Member Representative for his company.

The industrial leadership of the company continues under the direction of Walter F. Sheetz, president and a close associate of Mr. Mahon since the earliest days of the business.

L. A. Davis

L. A. Davis, vice-president and district sales manager, since 1945, of the Stulz-Sickles Co., Newark, N. J., passed away on July 13, 1956. He was 56.

Born in Hooper, N. Y., Mr. Davis settled in Wilkes-Barre, Pa., in 1929. Previous to his association with the Stulz-Sickles Co., in 1945, he was active in the reclamation welding industry and was a Manganal Distributor, where he used his wide, practical knowledge of applications. He was a member of the AMERICAN WELDING SOCIETY and on many occasions lectured at SOCIETY meetings.



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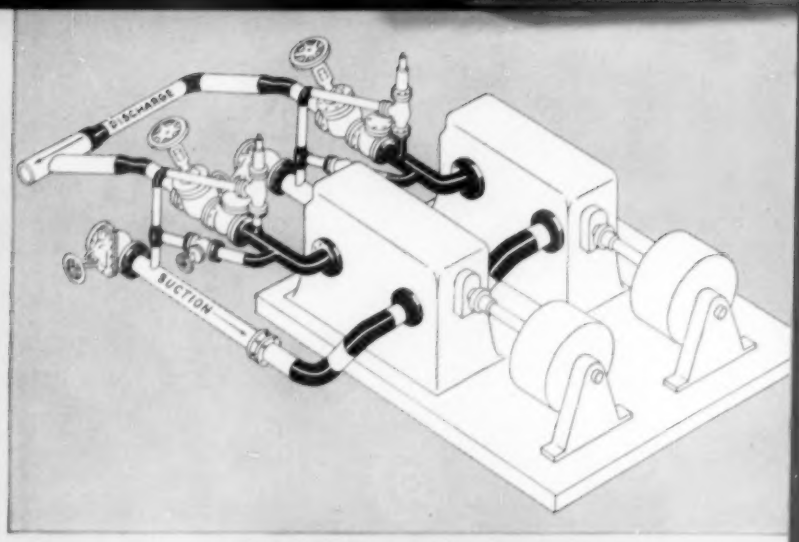

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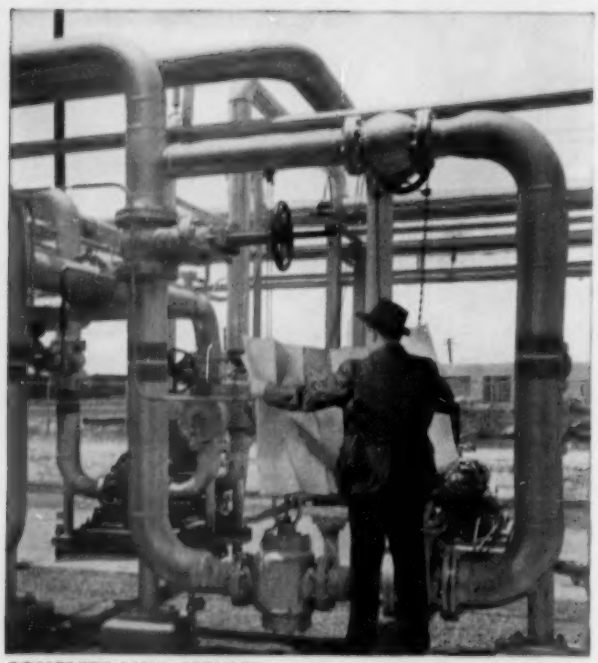

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NEWS of The Industry

Progressive Welder, Canada, Appoints General Manager

The Board of Directors of Progressive Welder, Canada Ltd., announce the appointment of E. J. Formhals as general manager of the Canadian operations, with headquarters in Chatham, Ont.

Mr. Formhals has been associated with American Steel Foundries, Garratt-Callahan Co.; was general manager of Saylor-Beall Manufacturing Co., and sales manager of the Electric Sprayit Co.

His position with Progressive Welder, Canada Ltd., brings him back into familiar surroundings and reassociation with the automotive and allied industries of Canada.

ONE-PIECE WELDED SKYSCRAPER

Giant fractionating tower—more than 40 ft higher than Niagara Falls—rises above skyline of Esso refinery at Baton Rouge, La., where it will help meet constantly increasing demand for highly refined oil and gasoline. Fabricated by Delta Tank Manufacturing Co., Inc., the new welded tower is believed to be the largest ever built. Twenty-one-story skyscraper weighs 410,000 lb, has an 11 ft 8 in. diameter, was fabricated from inch-thick steel plate and dwarfed the four railway flat cars on which it was shipped from Delta's plant

Resistance Welders Maintain Active Pace

For the sixth consecutive month, members of the Resistance Welder Manufacturers' Association have reported new business totaling more than $3^1/_2$ million. New orders during June of approximately $4 million brought the first half of 1956 54% above the similar period a year ago.

The regular monthly statistics showed that shipments are now also moving along quite briskly and for the six-month period averaged 34% ahead of the first half of 1955. The nearly $4^1/_2$ million in equipment shipped during June represents the highest monthly figure ever reported by members of the Association.

During the first half of 1956 over $20 million in machines were shipped to many different industries and these capital investments represent just about two-thirds of all of the business done by the members of the Association during 1955.

With $20 million in backlog there is no doubt that 1956 will be a record year for the resistance welding industry. In recent months members have predicted that the present high level of this industry's business will continue at least into early 1957.

GE Distributor Appointed

The Maine Oxy-Acetylene Supply Co. has been named a General Electric Co. welding equipment distributor. The announcement was made by C. I. MacGuffie, marketing manager of the company's Welding Department. Located on Adams St. in Auburn, the new distributor will handle the complete line of General Electric welding equipment and electrodes. This includes a-c, d-c, inert arc, semiautomatic and automatic, and atomic hydrogen equipment. The territory served is Androscoggin County, Me.

Wall Colmonoy Completes New Plant

Completion of new, modern foundry facilities for manufacture of the company's line of Colmonoy hard-facing alloys has been announced by the Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.

The new foundry contains a complete line of molding equipment, electric melting furnaces and production machinery for manufacturing and packaging

Colmonoy alloy welding rods, electrodes and powder. Sales, service, research and development and all manufacturing facilities are now centralized at this general office location.

Also included in the new building are expanded assembly, shipping and processing areas for Wall Colmonoy's Stainless Processing Division.

COMING EVENTS

A Calendar of Welding Activity

AWS National Meetings

1956 Fall Meeting:
October 8–12, Hotel Cleveland, Cleveland, Ohio

1957 Spring Meeting and Welding Show:
April 8–12, Hotel Sheraton, Philadelphia, Pa.

NWSA Zone Meetings

West Central Zone Meeting:
October 29–30, Hotel Nicolett, Minneapolis, Minn.

Western Zone Meeting:
November 1–2, St. Francis Hotel, San Francisco, Calif.

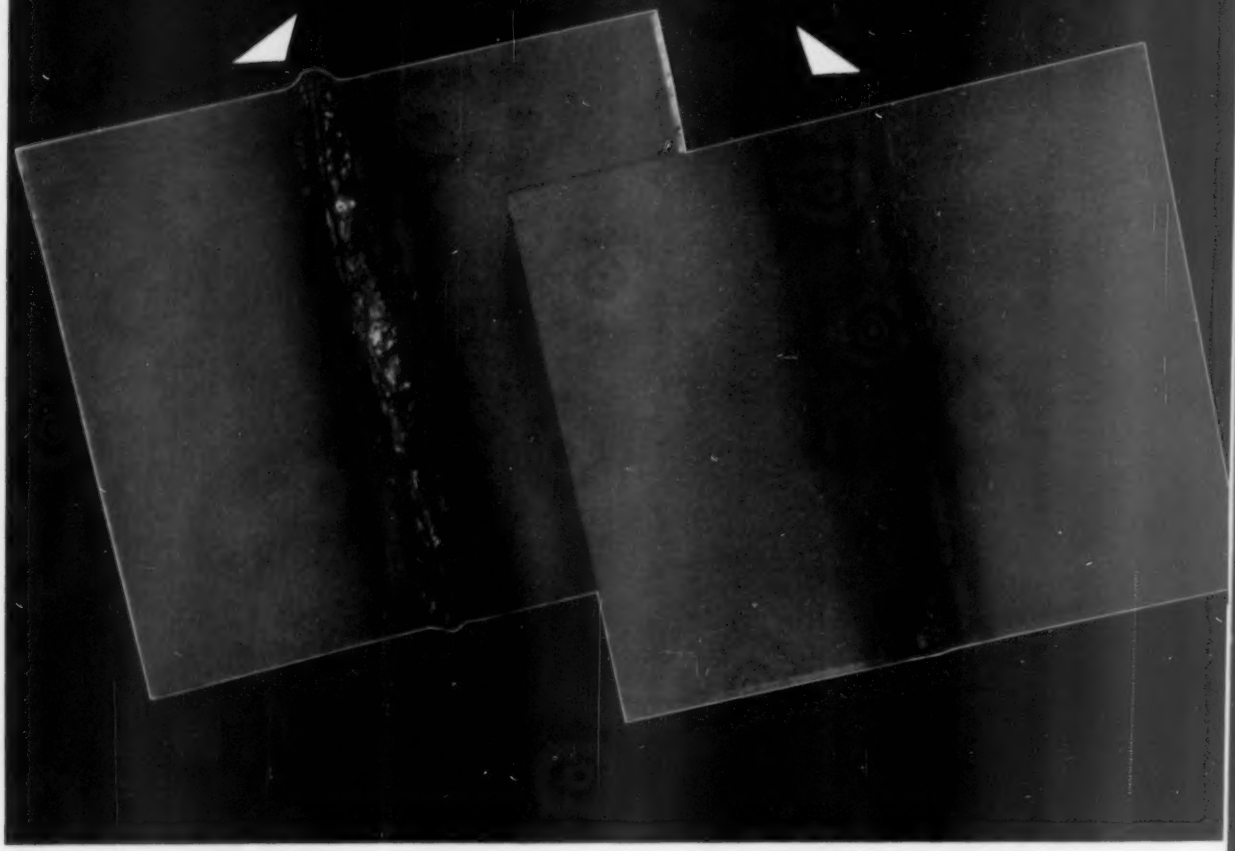
Southeastern Zone Meeting:
December 3–4, Dinkler-Tutwiler Hotel, Birmingham, Ala.

Southwestern Zone Meeting:
December 6–7, Statler-Hilton Hotel, Dallas, Tex.

THOMSON *announces* SYNCHRO-

CONVENTIONAL FLASH WELDING
requires a separate flash trimming operation

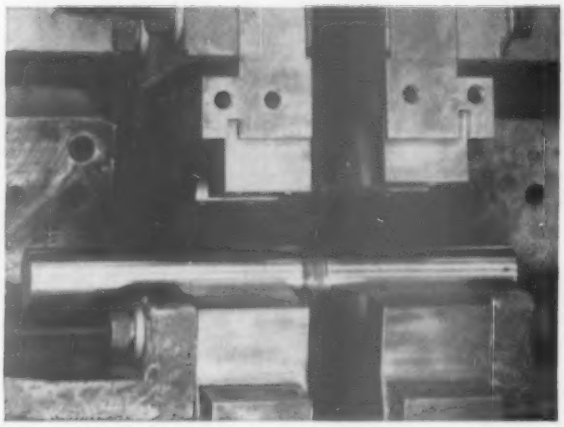
THOMSON "SYNCHRO-SHEAR"
no trimming required



A conventional flash weld, as shown at the left above, requires a separate operation to remove the flash extrusion. The cost of removing the flash in a flash trimmer, or by grinding, chiseling or flame cutting, usually exceeds the cost of making the weld.

A "Synchro-Shear" flash weld, as shown at the right, requires no trimming. Because the flash is trimmed as the weld is made, no further clean-up is necessary. Even when appearance is critical, finishing time is greatly reduced.

—SHEAR



Synchro-Matic Flash Welding with Automatic Flash Shear-Off

A MAJOR DEVELOPMENT IN FLASH WELDING STEEL
...ELIMINATES FLASH CLEAN-UP, SAVES HOURS OF FINISHING

Here, at last, is a flash welder for steel products that trims the flash while it makes the weld. It eliminates the need for separate flash trimmers — saves hours of cleaning up the flash extrusion or grinding away the upset.

Synchro-Shear, an exclusive THOMSON development*, adds automatic flash shearing to the proven performance of *Synchro-Matic* Flash Welders. Now you can flash weld carbon steel from mild to 1.00 carbon, high speed steel, high alloy steel and stainless steel, with speed, consistency and excellent weld quality while eliminating slow and costly post-weld clean-up. Synchro-Shear will weld and remove the flash from these materials in rectangular, round or irregular shapes.

Synchro - Shear Flash Welders are available in a complete family of RWMA sizes, tooled to suit your product. Write for complete information.

*"Pinch-Off Dies," now in wide use for removing the flash while welding aluminum, copper and other soft materials, are another Thomson development.

SEE SYNCHRO-SHEAR IN ACTION...
Booth 1751 — METALS SHOW, Cleveland, October 8 - 12

FOUNDED IN 1886 BY ELIHU THOMSON

INVENTOR OF RESISTANCE WELDING

THOMSON *Welders*

THOMSON ELECTRIC WELDER COMPANY
1363 PLEASANT STREET • LYNN, MASSACHUSETTS

Thomson makes a complete line of standard spot, projection, seam and flash-butt welders. Also, aircraft, brake shoe, fabric and other special purpose resistance welders.

LARGE AMERICAN GROUP ATTENDS NINTH ANNUAL ASSEMBLY OF IIW IN SPAIN

The ninth annual assembly of the International Institute of Welding was held on July 2 to 8, 1956, in Madrid at the invitation of the Spanish Institute of Welding. More than 800 delegates and their wives attended the assembly, the program of which included two meetings of the Governing Council of the Institute, four meetings of each of its fifteen technical Commissions and a public session for the presentation of papers.

The large American group which participated in the meeting included Dr. Howard Biers, Union Carbide & Carbon Corp., and retiring president of the IIW; A. Amirikian, Bureau of Yards and Docks; T. N. Armstrong, International Nickel Co., Inc.; David Brown, American Bureau of Shipping; John J. Chyle, A. O. Smith Corp. and president of AMERICAN WELDING SOCIETY; Prof. M. Cohen, Massachusetts Institute of Technology; M. A. Cordovi, Babcock & Wilcox Co.; D. K. Felbeck, National Research Council; Prof. A. M. Freudenthal, Columbia University; A. R. Gatewood, American Bureau of Shipping; F. X. Gilg, Babcock and Wilcox Co.; W. J. Harris, Jr., Battelle Memorial Institute; Dr. T. McLean Jasper, A. O. Smith Corp.; T. Embury Jones, Precision and Flexopress Corp.; A. R. Lytle, Electro Metallurgical Co.; Commander F. C. Munchmeyer, Ship Structures Committee; W. H. Munse, University of Illinois; F. L. Plummer, Hammond Iron Works; W. Spraragen, Welding Research Council; Rene Wasserman, Eutectic Welding Alloys; and J. H. Zimmerman, Linde Air Products Co.

The assembly was very efficiently organized by the Spanish Organizing Committee under the chairmanship of Señor M. de Miro Ramonacho. The center for the assembly was the Escuela de Ingenieros Industrales. The Spanish Reception Committee organized a number of functions, in particular a banquet held on Thursday, July 5th, which made it possible for all members of the assembly to meet socially. In addition, an excellent program of entertainment was provided for ladies who accompanied delegates.

A large number of delegates attended on July 2nd a public session organized in connection with the assembly. At this session, the general theme of which was "Productivity by Welding," 27 papers by authors from 11 different countries were presented by Spanish rapporteurs and fully discussed. The papers were divided into the following six groups: General Themes, Professional Training, Research and Control, Welding and Oxygen Cutting Processes, Shipbuilding, and Different

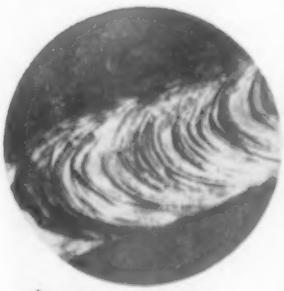
Several members of the American delegation and their ladies are shown during a public session of the International Institute of Welding. Left to right, in front row, are Mrs. Spraragen (in light dress); William Spraragen, Welding Research Council; A. Amirikian, Bureau of Yards & Docks, Navy Dept.; Mrs. Chyle; and "Jack" Chyle, president of American Welding Society. Seated behind Mr. Spraragen and Mr. Amirikian are D. K. Felbeck, National Research Council; Commander F. C. Munchmeyer, U.S.C.G.; and W. H. Munse, University of Illinois

Dr. Howard J. Biers (*right*), Union Carbide and Carbon and retiring president of the International Institute of Welding, is shown here discussing a point of interest with a fellow member of the Executive Committee of the IIW

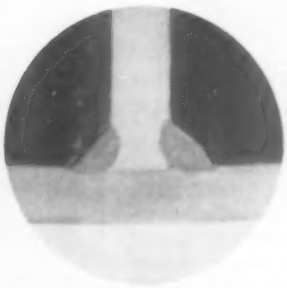
During one of the lighter moments of the meeting, a refreshing drink is enjoyed (*left to right*) by Dr. Biers; Embury T. Jones, Precision Welder & Flexopress Corp.; Mrs. Biers; Prof. Morris Cohn, Massachusetts Institute of Technology; Commander Munchmeyer and Commander Felix Caracciolo, USN

NEW ARCOS AEROCOR and FABRICOR DC ELECTRODES

*Assure all the benefits and properties you want when welding stainless steels



*sound weld metal . . . good bead appearance



*proper weld contour . . . good penetration

*quick, easy slag removal

*sound fillet welds—even when welded vertical up

● Whatever benefit you need, you'll get it along with easier, faster welding when you use *new* AEROCOR or FABRICOR DC Electrodes.

The AEROCOR Series is especially designed for welding stainless sheet metal. The FABRICOR Series is especially designed for heavy metal fabrication. Both are available in a wide range of stainless grades and diameters. Both are used with DC reverse polarity current.

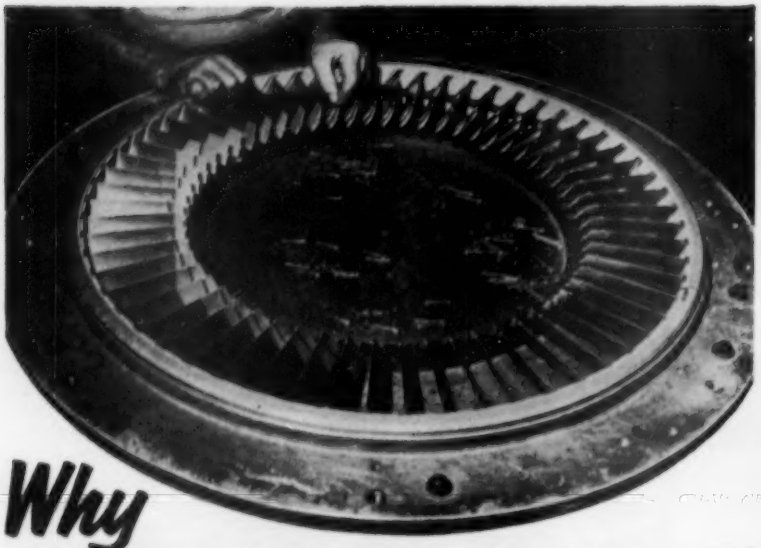
Before being publicly introduced, both types of these *easy-to-use* electrodes were demonstrated and tested in a group of specially selected plants and weld shops. The opinion of everyone involved was practically unanimous: AEROCOR and FABRICOR Electrodes are easiest to use . . . most uniform and dependable in results.

Electrode	Types Available						
Aerocor	308	309	310	316	347	349	410
Fabricor	308	309	310	316	347	—	—

FOR A FREE DEMONSTRATION in your own plant, simply drop us a line on your company letterhead. Of course, there's no obligation.

More than ever it pays to . . . **WELD WITH ARCOS**

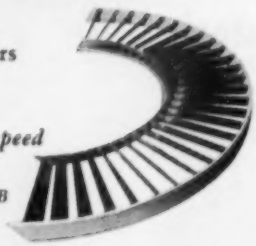
ARCOS CORPORATION • *1500 South 50th Street* • *Philadelphia 43, Pa.*

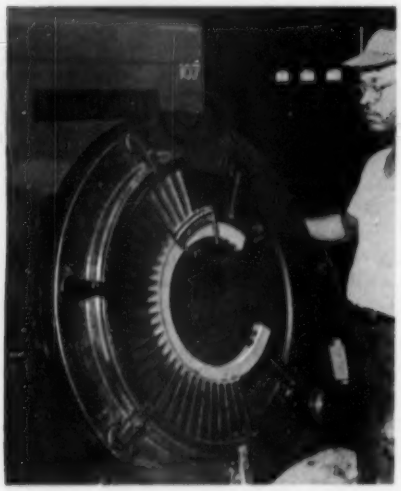


Why these stator blades for Curtiss-Wright J65 jet engines are brazed with EASY-FLO*

Allis Chalmers does this job with EASY-FLO for the same reasons that a great many manufacturers use this low-temperature silver brazing alloy — namely — the *great strength* and *virtual indestructibility* of EASY-FLO joints – plus the *speed* and *economy* with which they can be produced.

**EASY-FLO meets SAE Aeronautic Materials Spec. AMS 4770B*





THEY USE THE EASY-FLO FAST BRAZING FORMULA

PREPLACING the alloy – plus a setup that speeds handling and heating – that's the formula. Top picture shows parts being assembled in circular fixture with clips of EASY-FLO wire being preplaced over blade ends. At left – as half of fixture rotates, inner end of shroud passes through induction heating coil section at top. Time cycle for completing a half (28 joints) is 10 minutes. Blades are *nickel steel* and shroud ring is *brass*. EASY-FLO is particularly effective in joining dissimilar metals. Average strength of joints is *double* the specified minimum pull of 2800 lbs.

GET FULL EASY-FLO FACTS AND DISTRIBUTOR LIST

BULLETIN 20 explains why high-strength, speed and economy are inherent in EASY-FLO brazing. Also gives useful information about joint design and fast brazing methods. A copy, with Distributor List, will be sent at your request. Write today.

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

OFFICES and PLANTS
BRIDGEPORT, CONN.
PROVIDENCE, R. I.
CHICAGO, ILL.
CLEVELAND, OHIO
DETROIT, MICH.
LOS ANGELES, CALIF.
TORONTO, CANADA
MONTREAL, CANADA

There's no "...or equal" for EASY-FLO and SIL-FOS

Fabrications. One of the papers was presented by Mr. Lytle who spoke on "Research—An Aid to Productivity."

Dr. U. Guerrera (Italy) was designated as successor to the present president, Dr. Biers (USA), whose term of office will expire in 1957.

The 1957 annual assembly of the Institute will be held at Essen-Ruhr (Germany) from June 30th to July 6th, 1957, at the invitation of the Deutscher Verband fur Schweisstschnik. The Governing Council has also accepted invitations for the 1958, 1959 and 1960 annual assemblies from the Austrian, Yugoslovian and Belgian delegations, respectively.

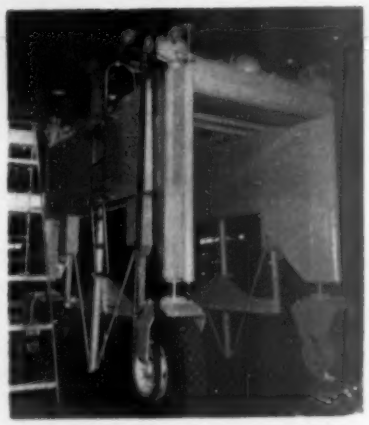
Worthington Appoints Distributors

The Plainfield Division of Worthington Corp. has announced the recent appointment of O. K. I. Welding Supply Co., 1630 Walnut St., Cincinnati, Ohio, and the Woodward, Wight & Co., Ltd., 451 Howard Ave., New Orleans, La., as their distributors for their line of welding positioners, turning rolls and fixturing equipment.

O. K. I. Welding Supply Co., headed by E. C. Caluwaert, will represent Worthington in the southwestern area of Ohio.

Woodward, Wight Co., Ltd., and its welding department will cover the Louisiana and Mississippi territory.

MAMMOTH WELDING JOB



With total load capacity of 30,000 lb, this super-size straddle truck for dockside use by the Belgium Port Commission was custom built by the Hyster Co., Portland, Ore. Welded with iron-powder electrodes, this bigger-than-usual job was completed in almost record time. Packages in sizes ranging up to 120 × 64 in. can be handled by this mechanical colossus. The job was the largest of this type ever to be tackled by the Hyster Co. (Courtesy of Air Reduction Sales Co.)

FOR SAFE WELDS

in fabricating high pressure, high temperature equipment...

MUREX®

CROLOY® Electrodes

■ More and more engineers have been discovering that Murex CROLOY electrodes are the answer to safe, crack-free welds. They are being used on chrome-moly steels for high pressure—high temperature service, and also for welding many problem steels.

Easy to handle without special training, the low carbon Murex CROLOY electrode leaves a finely rippled deposit free from porosity and with high ductility in the "as welded" state. It simplifies preheat operations and permits faster deposition at higher amperages, thus speeding production. The weld metal is insensitive to quench, free of slag inclusions, and practically eliminates underbead cracking.

CROLOY GAINS INDUSTRY APPROVAL

More than half of the top petroleum refineries in the country have already tested and approved Croloy electrodes for fabricating critical service equipment used in high pressure, high temperature operations. Other industries, too, have discovered the extra margin of safety provided by Murex Croloy electrodes.

Compare Murex CROLOY electrodes on the job yourself. Your nearest Murex distributor carries them—or write us for further information.

WELDING SUPPLIES
RADIOGRAPHIC EQUIPMENT
PLATING MATERIALS
ORGANIC COATINGS
CERAMIC MATERIALS
TIN & TIN CHEMICALS
METALS & ALLOYS
HEAVY MELTING SCRAP

METAL & THERMIT CORPORATION

GENERAL OFFICES: RAHWAY, NEW JERSEY

NEW ADDITIONS MADE TO MILLER PLANT

View of Miller plant with new wing shown at left

In December 1955, the first beam went up for the new building of the Miller Electric Manufacturing Co. On April 30, 1956 the company moved in.

In laying out the new facilities, a new plan was developed whereby material is fed in an uninterrupted flow to the production lines. The lines in turn, feed to a new three-port loading dock.

The small machine department

Center of new addition

Let's Get Down to Facts About CLAIMS—

Yes, we could run a full page telling you why our Products are better, but we prefer to have

HI-AMP ELECTRODE HOLDERS

prove their advantages by actual test with others —that's why we say, ask your Dealer to demonstrate a HI-AMP and you'll "see" why Welders everywhere prefer it.

LENCO, INC.
(Formerly Wagner Mfg. Co. Inc.)
JACKSON, MISSOURI

Weld with HI-AMP

INTERNATIONAL WELDING NEWS

IIW Commission VII—Standardization

By Arthur N. Kugler

This commission has, in effect, a twofold function: (1) to serve as the standardizing group for IIW, and (2) to effect liason with the International Standards Organization (ISO). From these functions, it will be obvious that Commission VII is involved in many projects both in IIW and ISO. It also appears that these projects originate with other commissions and do not come before Commission VII until such time as they are proposed as standards. Thus there are many joint meetings with subcommissions of other IIW Commissions as well as ISO/TC 44, the commission of ISO particularly concerned with standardization in welding.

Electrode Specifications—Activity in this field is carried on principally by IIW Commission II (Arc Welding) along with ISO/TC 44 Subcommission 3. A draft of a specification has been fairly well established covering electrodes 3.15 mm ($^1/_8$ in.) and larger. Much of this year's activity has centered around establishing requirements for sheet metal electrodes (below 3.15 mm). This has included tension tests on square groove butt joints welded from both sides. Difficulty was encountered in developing a suitable design, including dimensions for a reduced section tension test. This matter is still under study. At one meeting (IIW with ISO), the Belgian delegation pointed out the practice in use in USA (ASTM Specifications) of basing the mechanical properties and usability on the performance of the larger sizes of the same classification.

Another matter under consideration is the method for determining hydrogen in weld metal. While this is still in the discussion stage, it follows the American practice in all essential details.

Other work in the electrode field involves the development of tests to assess the cracking tendencies of electrodes. Work on this project is only now getting under way jointly by the IIW and ISO.

Gas Welding Rods—IIW Commission I has been working on specification for gas welding rods (ferrous). These were submitted through Commission VII to ISO/TC 44 who will edit and make minor revisions (apparently to bring into agreement with an ISO format). Following this, it will be re-submitted to IIW Commission I.

Resistance Welding—Work is under way between IIW Commission III and ISO/TC 44/SC 6 looking toward standardization in this field. Among the items reported are: dimensions of electrodes, electrode shanks and electrode holders; unification of T slots in plattens. Future work is to consider: classification of resistance welding machines; interchangeability of seam welding wheels; terminology.

Another activity is that of defining *Fundamental Welding Positions*. From the reports supplied, it appears that ISO/IIW are attempting to do with words the work we have done by means of drawings. It does not appear, at this time, to be too greatly different from the American standard.

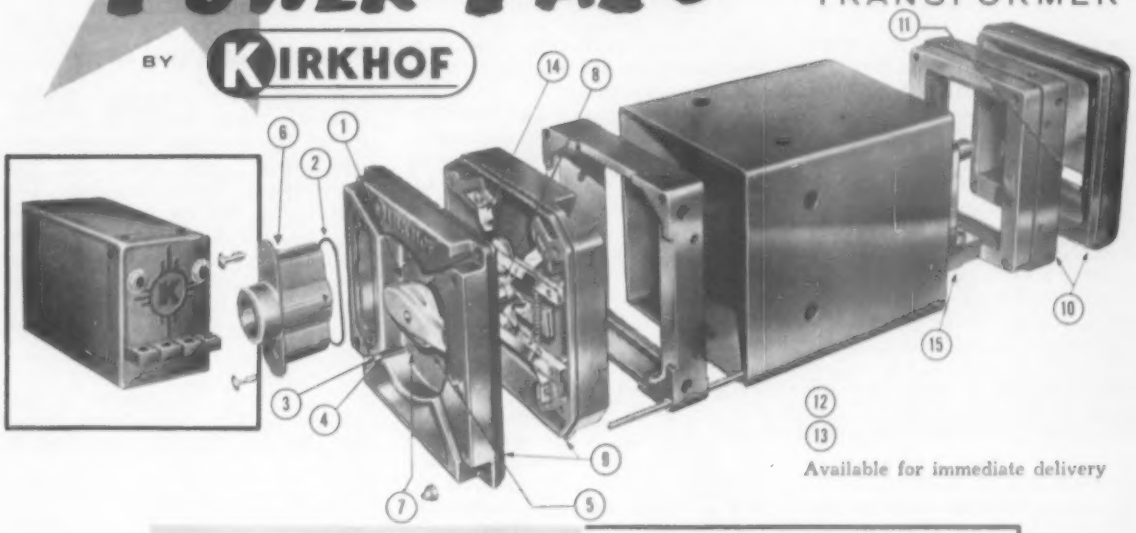
Along with these activities, Commission VII examined the recommendations on protective glasses, prepared by Commission VIII—Hygiene and Safety. It was recommended that Commission VIII proceed with the preparation of an international standard.

Arthur N. Kugler is the American delegate on Commission VII of the IIW.

A new Star
IN A FAMOUS WELDING EQUIPMENT FAMILY

"POWER-PA"K"
RESISTANCE WELDING TRANSFORMER

BY KIRKHOF



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MEETS ALL J.I.C. and R.W.M.A. STANDARDS

Sensation and NEW Standard of the Industry

RATINGS

The Kirkhof "Power-Pa"K" Transformer is available in 3 Basic Units

50 K.V.A. Type AR	440 V	Mod. 450 AR
50 K.V.A. Type AR	220 V	Mod. 250 AR
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60 K.V.A. Type AT	220 V	Mod. 260 AT
70 K.V.A. Type AW	440 V	Mod. 470 AW
70 K.V.A. Type AW	220 V	Mod. 270 AW

Special ratings on request.

CHECK THESE FEATURES THAT MEAN "BUILT-IN EARNING POWER"!

1. Water and oil tight seal around drive shaft. 2. Water and oil tight seal around Quick Disconnect Plug. 3. Tap Switch entirely water and oil tight, dirt-free. 4. Tap Switch slightly curved and channeled to allow drainage from around handle. 5. Raised section under handle prohibits water and oil from running in. 6. Kirkhof developed Quick Primary Disconnect Plug. 7. Four "on" positions and a positive "off" position. 8. Positive tap position indication and alignment. 9. Sealed between tap switch and cover. 10. Readily sealed between front cover plate and front body casting. 11. Can easily be sealed around secondary pads. 12. All parts good insulators. Completely eliminates possibility of transformer shorting out to ground at secondary and primary ends. 13. Lighter weight — highly compact. 14. Silver plated contacts. 15. Highly efficient water cooled secondary.

COMPACT SIZE — COOLER OPERATION
HIGHEST PRODUCTION — MAXIMUM VERSATILITY

KIRKHOF "Power-Pa"K" — the *one* Resistance Welding Transformer that brings you *profits*, not problems.

Write for illustrated literature.

SEE THE "POWER-PA"K" TRANSFORMER

SPACE 2860

AT THE METAL SHOW
CLEVELAND, OHIO

KIRKHOF
MANUFACTURING CORPORATION

2450 BUCHANAN AVE, S.W., GRAND RAPIDS, MICHIGAN

NEW LITERATURE

Filler Metals for Cast Iron and Nickel Alloys Covered in New Specifications

Two new specifications have recently been issued by the AMERICAN WELDING SOCIETY and the American Society for Testing Metals.

The first of these is a specification (AWS A5.15; ASTM A 398) covering filler metals suitable for welding gray cast iron, malleable iron and some alloy cast irons.

Sixteen classifications of filler metal are covered, including cast iron, copper-base, nickel-base and mild-steel electrodes for shielded-metal-arc welding. Also included are cast iron and copper-base welding rods for oxyacetylene and carbon-arc welding.

An appendix is included as an aid to users in selecting the most suitable filler metal for their needs. It tells how to prepare cast iron for welding, gives information on preheat requirements, welding technique, etc. It also contains data on postweld heat treatments and describes the effects of welding on cast iron.

Also included is a table giving the chemical analysis of all the classifications.

The second specification covers bare filler metals for the welding of nickel and high-nickel alloys.

This specification (AWS A5.14; ASTM B304) establishes 13 classifications of filler metal. This involves, among others, nickel, Monel, K Monel, Inconel, Inconel X, as well as various Hastelloy filler metals.

The chemical analysis of the different classifications is given in a table, in addition to standard sizes and lengths and packaging requirements.

The Appendix contains information on the use of each classification for joining different base metals with the following welding processes: (*a*) oxyacetylene, (*b*) atomic hydrogen, (*c*) inert-gas tungsten-arc (nonconsumable electrode), (*d*) inert-gas metal-arc (consumable electrode) and (*e*) submerged arc.

Copies of these specifications can be obtained at 40 cents each from the AMERICAN WELDING SOCIETY, 33 W. 39th St., New York 18, N. Y., or the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

Data on Low-Temperature Properties of Metals

A 400-page compilation of pre-1952 data on low-temperature properties of metals has just been published by the Army's Corps of Engineers and is available for industry use through the Office of Technical Services, U. S. Department of Commerce.

Valuable in particular as a background guide for designers and fabricators of low-temperature equipment, the volume contains papers presented at a Conference of Materials and Design for Low-Temperature Service sponsored by the Scientific Council, Engineer Research and Development Laboratories.

Although the conference was held in 1952, the book remains one of the few comprehensive collections of material on the subject. An extensive bibliography is included.

The illustrated volume, PB 121009 *Conference on Materials and Design for Low Temperature Service*, Engineer Research and Development Laboratories, U. S. Army, may be ordered from OTS, U. S. Department of Commerce, Washington 25, price $10.

Small-Parts Welding Equipment

A completely new, two-color, 16-page, illustrated welding equipment catalog, intended to be of help to manufacturers who have problems in joining small metal parts, has just been issued by Raytheon Manufacturing Co., Waltham, Mass. The catalog features Raytheon's line of welding heads, power supplies, all-electronic control units, and welding accessories.

Important facts covered in the new catalog range from information on proper selection of a-c or d-c (stored energy) welding systems, uses of resistance welding equipment, welding hints and Raytheon welding equipment applications.

For a free copy of the Raytheon Welding Equipment Catalog 2-100 and further information write to Raytheon Manufacturing Co., Department 6120, WJ, Waltham 54, Mass.

Properties of Nickel Alloys

A new, fully illustrated booklet entitled, "Some Properties of Inco Nickel Alloys at Low Temperatures," has recently been issued by The International Nickel Co., Inc. The bulletin describes the various wrought and cast high-nickel alloys used at low temperatures and arranges these data in a most useful manner for engineers and designers of equipment. The data cover only those materials which are in current use.

The booklet is available without charge through the Readers Service Section of The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.

Magnetic Force Welders

Precision Welder and Flexopress Corp. has published a new six-page bulletin covering its magnetic force welders. The bulletin points out the advantages of magnetic force welding to join difficult-to-weld critical materials. Also, light initial electrode pressure permits projection welding on materials whose projection would collapse under conventional electrode pressure. Write for Bulletin MF-100, Precision Welder and Flexopress Corp., Cincinnati, Ohio.

Copper and Copper Alloys

"Elevated-Temperature Properties of Coppers and Copper-Base Alloys" is another of a current series of reports prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals. This report is primarily a graphical summary of the elevated temperature data. Data for the coppers are limited to the wrought materials, while the data for the alloys apply to cast and wrought materials.

Graphical data include modulus of elasticity, tensile strength, yield strength (0.5% extension and 0.2% offset) reduction of area, elongation, stress for creep rates of 0.000001, 0.00001 and

0.0001% per hr and stresses for rupture in 100, 1000, 10,000 and 100,000 hr.

Included in the Appendix are data sheets giving the original data for drawing curves. The data sheets also give chemical composition shape, sizes, and processing information.

The book was prepared for the panel by Clair Upthegrove and Henry L. Burghoff. Copies of this 8½ by 11, heavy paper cover, 248-page book are available from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. at $5.50 each.

Safety Items

A new catalog, No. 33, has just been published by the Sellstrom Manufacturing Co., 306 Hicks Road, Palatine, Ill., and is now available to the trade. This catalog contains 54 full pages of a complete line of eye, face and head safety items for all types of industry.

A unique feature of this catalog is a special alphabetical listing of hazard, occupation and trade name with recommended items of goggles, helmets, face shields, respirators, etc. to use for different operations and in different fields. This prevents a grinder, for example, from using a goggle that would not provide adequate protection from flying chips.

A copy of catalog No. 33, which comes complete with prices, may be obtained by writing direct to the Sellstrom Co. on a firm's letterhead.

Health and Safety in Welding

The Council of the British Institute of Welding has announced the publication of a booklet of Health and Safety in Welding, which is the first of a new series of publications in course of preparation. This 64-page booklet has been compiled by a special committee in response to a demand for practical guidance on the precautions necessary to ensure the health and safety of those working with the welding and cutting processes. The contents are of a purely practical nature, and no attempt has been made to deal with the more advanced technical and scientific background of the subject. The booklet is offered as a concise work of reference, both for the welder and for those responsible for the supervision of welding.

Price for single copies is 42 cents per copy. For 20 copies or more it is 28 cents per copy. Postage extra.

Hard-Surfacing Materials

Publication of a comprehensive comparison chart for selection of hard-surfacing welding materials has been announced by the Rankin Manufacturing Co., Alhambra, Calif. The chart is described as making it easy for hard-surfacing material users to select the appropiate Ranite rod for their specific application in comparison with other rods available.

Listed across the top of the easy-to-follow chart are hard-surfacing applications such as build-up, abrasion and shattering impact, abrasion and severe impact, severe abrasion and medium impact, etc. The first column lists various manufacturers with their products appearing across the chart under specific applications where they are used.

Alloy News

The latest copy of the Colmonoy Alloy News, Vol. 1, No. 8, has just become available. Those interested may obtain a copy by writing directly to Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.

SUPER "JIFFY"*
SOLDERING
and BRAZING
TORCH!
*Reg. U. S. Pat. Off.
Torch Tips are always in Correct Working Position!
Just seat the tip firmly in place and it's ready for the job!
"All-Position" Valve gives "ON—OFF" control at any point on its entire circumference.
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Featuring the "ALL-POSITION" VALVE
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Off
Exclusively with Meco
Distributorships still open... Write Today!
• Economical Air-Acetylene Torch
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• Tip Sizes available for large or small jobs
• Takes "Jiffy" Point Burner Tip, Soldering Copper and Halide Leak Detector
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MODERN ENGINEERING COMPANY
3407 PINE BLVD. • ST. LOUIS 3, MO.

Carbide Tool Line

A new industry-service brochure on carbide rotary cutting tools has been issued by the Abrasives division of Elgin National Watch Co.

The booklet presents Elgin's complete line of solid carbide end mills, rotary files and miniature cutters, and explains the use of such tools for scale and flash removal, blend and twist welds, machining in tight spots, as well as for deburring, counter-sinking, and chamfering.

The booklet is available without cost from the division, 107 National St., Elgin, Ill.

Thyratrons and Ignitrons

A selection chart listing the essential characteristics of 75 power rectifiers and control tubes now is available from the General Electric Co

The chart classifies 46 thyratrons according to type, lists anode and cathode current and voltage ratings, and gives the average control characteristics of each tube.

Twenty-nine ignitrons are listed according to classification—welding-control tubes, frequency-changer welding tubes and power rectifier tubes. The chart also lists maximum ratings of each ignitron.

The chart (ETD-1322) may be obtained from General Electric Tube Sales, 1 River Road, Schenectady, N. Y.

Wire Products

A new wire catalog, featuring improved design characteristics, has been announced by the Parts Division, Sylvania Electric Products Inc.

The catalog is a complete listing of Sylvania's growing wire, ribbon, weld and carbostrip products manufactured by the Parts Division. Wire and ribbon types include alloy, clad and plated.

The new issue is said to replace a previous catalog which was issued in October 1954, but rendered obsolete by recent new wire developments.

The catalog is available from Sylvania's Parts Division sales offices or from Sylvania Electric Products, Inc., 12 Second Ave., Warren, Pa.

Metallic-Powder Cutting Equipment

A new four-page folder has just been produced by Air Reduction Sales Co. covering their complete line of metallic-powder cutting equipment for cutting and washing stainless steels, other high alloy steels and cast iron.

Both vibratory and pneumatic-type powder feeders, along with hand and machine torches, are illustrated and described.

For additional information, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y. Specify Form ADC 839A.

Silver-Bearing Solder

A new 2-page technical bulletin on silver-bearing soft solders is now available from Alpha Metals, Inc. A complete discussion on silver scavenging, selection, applications and available alloys has been included in this bulletin.

A graph designed to help determine the proper alloy for use in a particular application is also a part of the bulletin.

This information may be of particular interest to those involved in the problems of soldering silver-plated parts.

Write for bulletin No. 3, Alpha Metals, Inc., 56 Water St., Jersey City, N. J.

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PIONEER FOR MODERN WELDING

"Shortstub" ELECTRODE HOLDER

The jaws substitute for stub waste by splicing a 2 inch extension to the length of every electrode.

"Multi-Pic" CONTOUR CLEANER

Delivers FIVE surface cleaning blows with each swing and lasts FIVE times longer than single headed hammers.

"Pro-Clamp" MECHANICAL HANDS

MODERNIZE the fabrication of plates, shapes, rods, bars, pipes, etc. MAKE fitting, positioning, holding, and welding a fast, accurate, inexpensive, one-man job.

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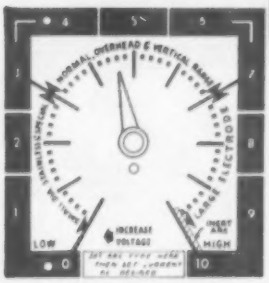
ONLY THE

VICKERS* Controlarc DC Welder

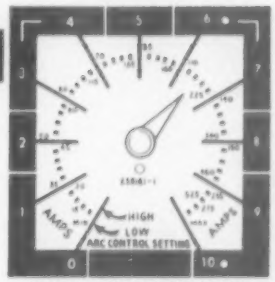
OFFERS ALL 3 OF THESE ADVANCED FEATURES FOR MORE VERSATILE AND MORE RUGGED WELDING PERFORMANCE



ARC CONTROL

1 SELECTION OF ARC TYPE required for vastly different welding jobs, and adjustment necessary to suit the individuality of the operator and the welding job.

2 DUAL CONTINUOUS CONTROL in a rectifier machine. Can vary the current from minimum to maximum, and vary the type of arc, in continuous stepless self-indicating dials.



CURRENT CONTROL

3 REMOTE CONTROL of both these functions in a handy box that plugs into the front of the welder can save floor space by mounting welder out of precious production area.

FOR THE HEAVY CONTINUOUS PRODUCTION JOB—THIS WELDER CAN "TAKE IT"!

Plus these Additional Optional Exclusive Features

CONSTANT POTENTIAL (CP) ADAPTOR

Instantly converts standard welder into multi-purpose CP source, for automatic or semi-automatic Consumable wire inert gas, or heavy flux automatic arc welding. Combination retains all its ideal features for Tungsten Inert gas jobs and manual metallic electrodes.

SLOPE CONTROLLER

Permits automation of many Tungsten Inert Gas jobs which previously had to rely on manual skill—by providing precision stepless control of starting UP (or down) SLOPE, and crater elimination DOWN (or up) SLOPE with individual adjustment of time and current (or percent of welding current). Practical precision timing from near instantaneous to as much as 21 seconds of both slopes. Inquiries on your particular slope controller applications are invited.

*TRADEMARK

WRITE TODAY for Complete Information on this Outstanding Welder

VICKERS ELECTRIC DIVISION

VICKERS INCORPORATED a unit of Sperry Rand Corporation

1875 LOCUST STREET • SAINT LOUIS 3, MISSOURI

NEW PRODUCTS

D-C Rectifier Welder

A new rectifier welder with "Diverter Path" control is being announced by Hobart Brothers Co., Troy, Ohio.

New case design permits easy-to-remove side panels. Recessed control panel has polarity reversing switch, three-coarse current adjustments with

rheostat control for fine current adjustments. The rheostat can be removed for remote control. The welder has both thermostatic and current overload protection. A magnetic line contactor is supplied at no extra cost.

Unit is available in 300- and 400-amp models.

Ignitron Tube

An improved ignitron tube (Type WL-5822-A), for control of frequency-changer resistance welders, is now available from the Westinghouse Electric Corp.

The WL-5822-A directly replaces the WL-5822 and is a sealed, stainless-steel jacketed, water-cooled, mercury-pool tube capable of intermittent ignitor

service. It has a 1200- or 1500-volt maximum anode voltage rating with 1500- or 1200-amp maximum anode current.

It features a provision for thermostatic control, which when equipped with suitable thermostatic switches, conserves cooling water consumption and simultaneously protects the tube and associated equipment from overloads and overheating.

For further information, write Westinghouse Electronic Tube Division, Box 284, Elmira, N. Y.

Silver Brazing Preforms

Mansol Ceramics Co., of Belleville, N. J., has announced the opening of a division of the company for the production of silver brazing preforms in almost any size and shape desired.

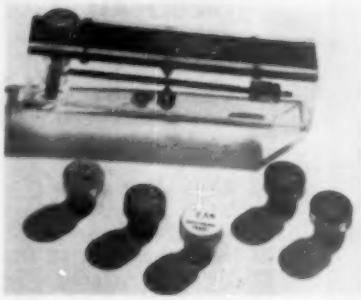
The silver brazing preforms are made either to a standard silver formula or can be made of nearly any analysis of the alloy. Tolerances are closely controlled. Special applications will be prepared for prospective users by contacting the design engineering department. These special formulas will be subjected to all normal tests and to special standards as set by the customer.

Complete information about the silver brazing preforms is available on request from the company. Please address all inquiries to Mansol Ceramics Co., Research and Development Division, 140 Little St., Belleville, N. J.

Ferrite Indicator

The Severn Engineering Co., Inc., announces the availability of their Ferrite Indicator. It is reportedly a simple, rugged, nondestructive inspection instrument developed for laboratory, shop and field use. Its go-no-go feature is said to permit instant acceptance testing of austenitic stainless and manganese weld and base metals. It requires no external standards, no adjustments, no visual readings, and is unaffected by position. Also, according to manufacturer, it performs equally well on sheets, plates, rods, irregular shaped objects, and individual parts of complex components. It is effective in locating areas of high and low ferrite content in heterogeneous products.

The Indicator covers all practical welding requirements; inserts being



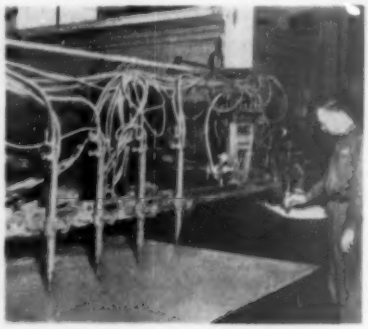
available in the range of 1.5% to 15% ferrite. It weighs but 3 oz. and is 5 in. long.

For complete details, write to Severn Engineering Co., Inc., Mfrs. Ferrite & Permeability Indicators, P. O. Box 944, Annapolis, Md.

Automation in Cutting

Harris Calorific Co., Cleveland, Ohio, manufacturers of cutting and welding apparatus, have come up with a system which reportedly brings automation to the cutting operation.

"Cut-O-Mation" is what Harris is



calling this system, which utilizes the Harris 98-T Machine Torch in combination with the 48-DC Oxygen Saver.

According to manufacturer, this combination makes "Cut-O-Mation" possible for the metal working industry, with the result that cutting speeds are increased up to 30 to 50%, oxygen consumed in preheat flames is reduced up to 80% and over-all oxygen consumption lowered by as much as 20%, and slag removal reduced to a minimum.

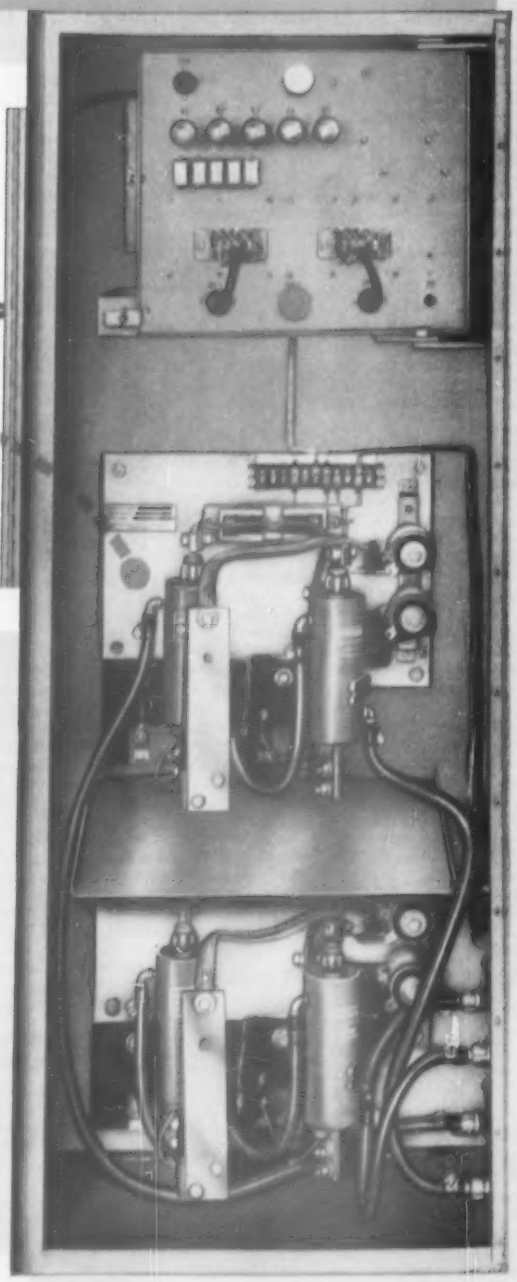
"Cut-O-Mation" is a system whereby several cutting torches are lined up in

Amperex® IGNITRONS

used by TAYLOR•WINFIELD

Tri-Phase NEMA Type N2 Resistance Spot Welder Control for use on 3 Phase Rectifier Type Machines by Taylor-Winfield and equipped with Amperex AX5551A or AX5552A Ignitions

Note convenient and compact installation of the Amperex ignitrons, made possible by the heavy, flexible anode leads.



Outstanding features of Amperex IGNITRONS:

- *exclusive "long-life ignitor"— promotes ease of firing and greatly extends length of service*
- *removable, heavy, braided, copper anode lead*
- *visible glass anode seal —simplifies observation of firing*
- *insulating shield around ignitor terminal*
- *rugged stainless and alloy steel construction*

Prove to yourself—
Amperex Ignitrons give lowest "per-hour-cost"

Amperex ELECTRONIC CORP.
230 Duffy Avenue, Hicksville, Long Island, N. Y.
In Canada: Rogers Majestic Electronics Ltd.
11-19 Brentcliffe Road, Leaside (Toronto 17)

AMPEREX ignitrons are available in both conventional and thermostatically controlled types. No derating is necessary for the temperature-controlled types.

Write directly to the factory for data sheets and the name of your nearest distributor.

Plant, Research Laboratories and World Headquarters

BETTER FASTER

Low Temperature EUTECTIC WELDING ALLOYS

STRONGER WELDS

EUTECTIC Welding News

PUBLISHED BY EUTECTIC WELDING ALLOYS CORPORATION, 40-40 172 STREET, FLUSHING 58, NEW YORK, N. Y.

"EUTECTIC" WELDING HEADLINES • TIME-MONEY-MACHINERY SAVERS

WELD SAVINGS APPLICATION REPORT "FINDS" $2754 FOR SO. TEXTILE MILL

Scores of leading industries are beginning to appreciate and utilize the tremendous opportunity available for cutting maintenance and production costs with welding. They are accomplishing this through a Weld Savings Application Report prepared without obligation by trained Eutectic District Engineers. This Report is a welding specialists recommendation for lowering costs and increasing production.

Use of this new and exclusive service pioneered by "Eutectic" has given one Southern textile manufacturer added savings of $680.00 through weld-repair of loom back boxes, card dobber cylinders and other cast iron equipment previously considered non weldable. The same Weld Savings Application Report showed the way to a $310.00 saving by replacing conventional overlay materials with Eutec-Trode 1851 (DC) for picker feed and calendar rolls. Copies of the Weld Savings Application Report left with the Purchasing Agent and Weldor as a guide to welding procedures, highlighted 38 additional weld savings applications.

A copy of this Weld Savings Application Report and reprints of similar reports prepared for varied industries (TIS 2637) are available from Eutectic District Engineers or from Eutectic's Technical Information Service.

ARCTIC AIR BASE OFFICERS CALL WSA "UNDERESTIMATED" AT $2,000,000

A recent Weld Savings Applications Report conducted by two Eutectic engineers for the U.S. Air Force was judged to have saved closer to $10,000,000 for the Northeast Air Command than the original estimate of $2,000,000. The basic purpose of the survey was to educate maintenance and repair personnel in the latest development in welding materials and techniques, and demonstrate how they could help to restore equipment damaged by 30 to 40 degree below zero temperatures, and over 100 miles per hour winds.

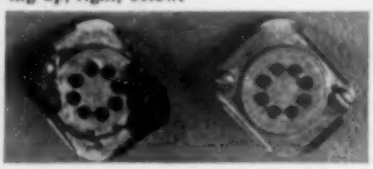
In one case, Air Force weldors successfully joined corrugated steel pipes at 20 below zero with Steel Tectic #1, a low amperage, multiple pass alloy for mild steel. Several cracked diesel engine blocks were salvaged by preparing with Eutectic's CutTrode and Chamer-Trode in the damaged areas, and welding with Xyron 2-24 and Xyron 2-25. High strength, porosity-free welds were produced by these new and advanced low temperature, cast-iron EutecTrodes. In this application alone, Eutectic engineers achieved savings close to $1,000,000. Additional savings were realized in the repair of 350 cylinder liners valued at about $1,000 each. EutecRod 140, a high strength, high density deposit, was recommended for rebuilding 50 aircraft cylinder heads, resulting in additional savings of $500,000. Eutec-TinWeld proved very effective in repairing diesel engine radiators; and EutecRod 1602, a specially developed, low-melting silver type alloy was the only successful method found for salvaging 50 aircraft fuel tanks. A ten minute, 16 mm film packed with practical know-how for saving time, machinery and money, showing some of the new techniques and developments utilized by the U.S. Air Force in Greenland is available free of charge.

$33,000 SAVED IN HEAVY EQUIPMENT

Replacement parts being discontinued for outdated earth moving equipment, an attempt to redesign the transmission cases got under way in a Mid-West plant. Arrow in illustration above indicate areas of great strain. Using EutecTrode 680 AC-DC, two machines were welded, tested for eight months, and then torn down and inspected. The welds were perfect in every detail. Subsequently, five machines were completely rebuilt, plus six more for other companies. Not one has failed. No keys were used; the weld takes all the strain. EutecTrode 680 AC-DC is an all-purpose, corrosion resistant electrode for very high alloy and carbon steels with ultimate tensile strength up to 120,000 psi.

EUTECTIC-SILWELD ELIMINATES WASTE AND COSTLY "CLEANING UP"

An electronics manufacturer thought he would have no problem silver-soldering screws to radio sockets, UNTIL he tried to do it with conventional materials. The results he got are shown in the photographs at left, below. The solution was the use of Eutec-SilWeld 1618, which eliminated the waste of costly alloy and expensive cleaning up, right, below.



Eutectic-SilWeld is a new, high silver content alloy blended with special flux, in convenient, "paint-on," paste form. It eliminates the need for costly rings, shim and strips, is easier to use than conventional silver rods and alloys that require high heats. Many weldors are using Eutec-SilWeld 1618 to promote heavy "surface alloying," and to increase the flow of bead-forming alloys into butt joints.

The area of the weld where free flow is desired is simply painted with Eutec-SilWeld 1618. The area where a bead is required is left bare. The weldor then "runs" a EutecRod like 16FC, 185FC, 18FC, 146FC or 20FC. The result is a neat bead and a "neater" saving. As EutecRod mixes with the silver in Eutec-SilWeld 1618, the melting point is lowered. Tinning, cladding, coating and filling defects and porosities are all situations where the new Eutec-SilWeld 1618 offers worthwhile savings above the cost of welding with conventional silver brazing alloys.

CONTROLLED AREA HEATING GIVES MAXIMUM CASTINGS WELDS WITHOUT WARPAGE

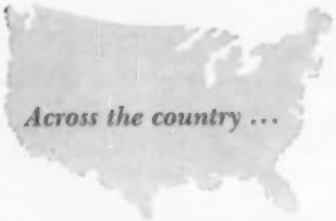
To insure a good weld without warpage on cracked heads and blocks, many repairmen now follow this effective procedure: First they thoroughly clean the area around the break. Eutectic's Form-A-Jig is then packed to both the outer and inner surfaces of the casting, to within an inch of the break, localizing the heat to the weld area, and controlling warpage. The hole is then repaired with EutecRod 1900 and Eutector 1900 flux, a superior weld combination for magnesium. The excellent heat absorption qualities of Form-A-Jig permit the casting to be picked up with bare hands, without discomfort, as soon as the weld is complete.

EUTECTOR ALBRO-FLUX 1601 ELIMINATES ALUMINUM BRONZE JOINING PROBLEMS

Eutectic District Engineers are introducing the latest result of Eutectic's flux-minded research. Eutector Albro-Flux 1601, the newest of Eutectic's temperature indicating fluxes, helps eliminate the problems associated with joining and repairing all grades of aluminum bronze, and is ideal for joining aluminum bronze to non-ferrous metals normally silver bronzed.

Such industries as, fabricators of small marine parts, will find the new Albro-Flux 1601 solves problems found in torch-joining aluminum bronze. It makes possible joining and repair of parts too small for arc welding. Albro-Flux 1601 is particularly recommended for use with EutecRods 1600, 1601, 1700 and 1801.

The activity range of Albro-Flux 1601 is between 100 and 1600 degrees F. It permits use of a great variety of silver solder type alloys and allows replacement of standard tin bronzes with alloys providing much higher joint strength. The increased wetting activity and the ability of Albro-Flux 1601 to dissolve aluminum oxide means the molten silver alloy with which it is used flattens out and flows readily.



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When you need a Eutectic District Engineer for on-the-spot assistance, you'll get immediate action by any of the above centers.

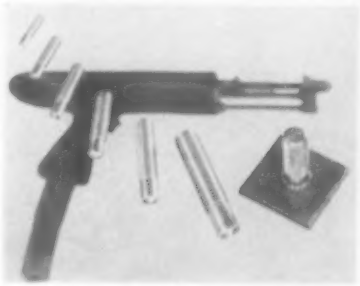
EUTECTIC
WELDING ALLOYS CORPORATION
40-40 172 Street, Flushing, New York, N.Y.

tandem formation and operated from a single station. Preheat oxygen pressures are controlled to as many as 8 machine cutting torches simultaneously, with a mere flick of the wrist.

"Cut-O-Mation" is said to achieve its most spectacular results when used with natural gas or propane gas. However, it may be used with any of the popular fuel gases—acetylene, hydrogen, natural or L-P.

Welding Studs

A new type threaded-end welding stud which, according to the manufacturer, offers important design improvements and costs less than the standard product it will largely replace, has been announced by the Nelson Stud Welding Division of Gregory Industries, Inc., Lorain, Ohio.



Designated Type CP, the new granular-fluxed studs have tensile strength as much as 13% greater than the former standard MG studs and provide improved welding qualities. The same templates now being used with Nelson MG studs can be used with CP's up to and including $\frac{1}{2}$-in. diameter, as the ceramic ferrules used in welding have identical outside dimensions.

For complete details, write directly to company at above address.

Hard-Surfacing Flux

The Lincoln Electric Co. of Cleveland 17, Ohio, has announced a new addition to its line of hard-surfacing agglomerated alloy fluxes. The flux, H-560, is used with the submerged-arc welding process to produce a hard-surfacing deposit using a mild-steel electrode. It is an agglomerated mixture of fluxing materials and alloys which will produce a high-carbon, high-alloy weld deposit when used with Lincoln's L-60 mild-steel automatic electrode wire. Alloys are added to the weld deposit through the flux. Agglomeration bonds and alloy particles together, each H-560 particle containing flux and alloy in proper proportion.

According to the manufacturer, it will make a deposit with a hardness of 53 to 61 Rockwell RC that cannot be oxygen cut or forged.

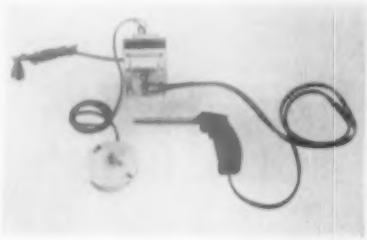
H-560 flux is claimed to be excellent for the fabrication and maintenance of wearing parts where the service involves severe abrasion and medium impact. It will perform successfully under abrasive conditions at temperatures as high as 1100° F.

For complete details write directly to company at above address.

Soldering Gun

Heavy-duty performance in a 6-oz soldering gun is claimed by the Phillips Mfg. Co., Inc., of Minneapolis, for its model SF-100 Flash.

Developing operating temperature in a matter of 4 to 6 sec, the SF-100 is said to be able to perform in situations where larger guns often prove to be too



bulky and cumbersome. Pistol type casing is of phenolic rubber and the rigid tubular barrel allows the use of a variety of interchangeable tips.

More complete information can be obtained by writing Dept. KP, Phillips Mfg. Co., Inc., 2816 Aldrich Ave. S., Minneapolis, Minn.

Welding Torch

Air Reduction Sales Co. has announced the availability of a new welding torch, which features a "quick shut-off" valve, for production line, light-gage welding and brazing jobs. It is said to be especially suited for

production welding in the refrigeration and automotive industries, and other light work where intermittent welding is involved. Known as the Airco Style 600 Shut-Off Torch, it is a well-balanced unit that weighs only 14 oz. and is $7\frac{1}{4}$ in. long. A complete line of tips, mixers and extensions are available for use with this torch.

The "quick shut-off" valve permits instantaneous closing of the gas passages so that the operator can move from one

"I recommend the Airco 387 Electrode for welding mild steel"

It's the most versatile of all 6012 electrodes. Good wetting action of the Airco 387 electrode permits the use of high current and travel speed on both thick and thin sections. The fluxing action of the slag results in smooth, uniform deposits of superior appearance with minimum spatter. Especially recommended for single pass horizontal fillet welds because of ease of handling, good weld profile and ability to withstand high welding current.

This is but one of many electrodes in Airco's complete line that also includes stainless steel, hard-facing, cast iron, general and special purpose electrodes. Send for free Airco Electrode Guide which will help you select the right electrode for your specific job. Request catalog 1318-WJ.

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New York 17, N. Y.

Offices and dealers in most principal cities

On the west coast—
Air Reduction Pacific Company

Internationally—
Airco Company International

In Cuba—
Cuban Air Products Corporation

In Canada—
Air Reduction Canada Limited

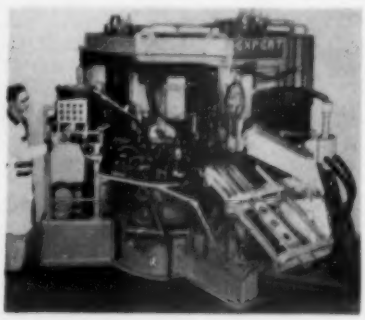
weld-joint to another without the loss of oxygen and acetylene, and without carrying a "live" flame from one area to another.

For more information about the new Airco 600 Torch, write Air Reduction Sales Co., a division of Air Reduction Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Automated Index Welder

A new Expert automated 7-station rotary index projection welding machine designed for accurately positioning and welding nuts or brackets to surfaces of production parts is now available from Expert Welding Machine Co., 17144 Mt. Elliott Ave., Detroit 12, Mich.

The machine features a stop and start cam-drive mechanism that controls



index and weld sequences, bowl feeders equipped with hopper feed tracks, a transfer device for delivering weld nuts to the projection welding guns and a unique mechanism for projection welding brackets to production parts. An air-powered unloader mechanism automatically removes the finish-welded assemblies from the machine and deposits them on a conveyor. The motor-driven machine is electrically controlled and air operated.

For complete details, write directly to the company at the above address.

All-Position Electrode

The Lincoln Electric Co. of Cleveland, Ohio, has announced a new E6010 electrode, Fleetweld 5-P, suitable for all E6010 applications, but especially designed for pipe welding.

According to manufacturer, Fleetweld 5-P can also be used for pressure vessels, X-ray applications, and other ASME code work. It also is suitable for all-position structural welding, machinery weldments and ship welding. It conforms to AWS E6010 requirements. It has been approved by the American Bureau of Shipping. It is available in $^{1}/_{8}$ and $^{5}/_{32}$ in. diameters.

For complete details, write directly to manufacturer at above address.

Welding and Cutting Outfits

Two new, light range oxyacetylene outfits, the Purox W-200 Aircraft Welding and Cutting Outfit and the Purox W-200 Light Welding and Cutting Outfit, are described in a fully illustrated six-page folder recently published by Linde Air Products Co., a division of Union Carbide and Carbon Corp. These outfits are designed expecially for production welding and limited cutting of light-gage metals in aircraft and small parts manufacture, and for repair and maintenance operations in auto body shops, sheet metal shops, and garages.

Free copies of the folder describing the new outfits may be obtained by writing to Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y. Ask for Form 50181.

Isotope Radiography Machine

The most powerful isotope radiography machine ever developed for portable field work has been delivered to the Newport News Shipbuilding and Drydock Co. by the Nuclear Systems Division of the Budd Co.

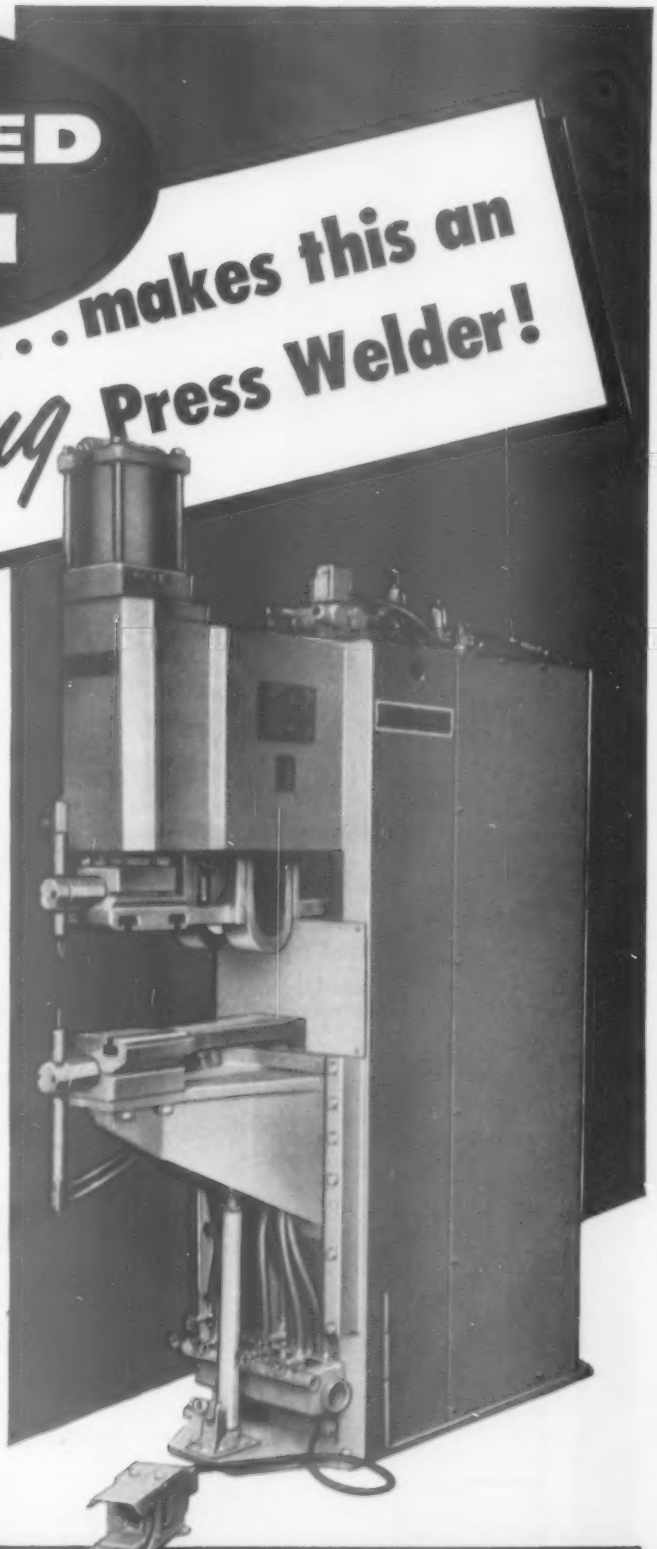
Employing the radiation from a 50 curie cobalt-60 source, a radioactive isotope, the Multitron, Budd's name for this machine, may be used to detect possible defects in atomic reactor shielding.

Described as being capable of penetrating very heavy sections of steel, lead and other materials, the Multitron is said to accomplish the same job as a 2,000,000-volt X-ray machine, although it costs but a fraction of the price and requires no special installation. Completely self-contained, this unit requires no power supply and can be wheeled readily by one man to any in-plant location or taken out for field work.

For complete details write to the Budd Co., 2450 Hunting Park Ave., Philadelphia 32, Pa.

ADVANCED DESIGN

..... makes this an *Outstanding* Press Welder!



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915 Oakland Avenue • Pontiac, Michigan

Arc Weld Antispatter

Linde X-7 Anti-Spatter, a new silicone-containing emulsion that reportedly cuts weld finishing time and costs by eliminating chipping, grinding,

and other postweld cleanup operations, has been introduced by Linde Air Products Co., a division of Union Carbide and Carbon Corp. Applied to the spatter area before arc welding, Anti-Spatter is said to form a thin protective coat over the weld metal. This invisible coat prevents molten spatter from sticking, and enables the operator to whisk away spatter with a cloth or spray after welding.

The key ingredient of Anti-Spatter's exclusive formula is a special silicone, one of a relatively new and extremely versatile chemical family, used for the first time as an "antispatter" agent in Linde X-7 Anti-Spatter.

According to manufacturer, Anti-Spatter is nontoxic, odorless, and nonflammable—assuring maximum safety and operator comfort. It can be used on any metal without affecting weld quality, and costs less than one cent per square foot of treated surface to use on normal arc-welding operations.

Free copies of a folder giving complete information on Linde X-7 Anti-Spatter may be obtained by writing to Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y., and asking for Form 50217.

Safety Hat

Greatly improved comfort and more durable construction are claimed for the new headgears now used in the Jackson Products, Inc., line of fiber glass safety hats and caps.

This headgear, adjustable by clearly marked hat sizes, has hammock straps and sweatband assembled in one unit, with Nylon cord providing the required adjustment over the top of the head.

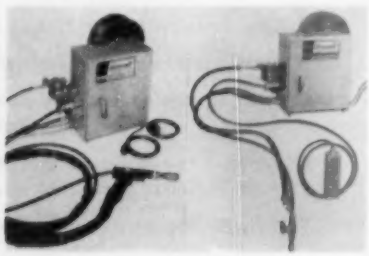
New plastic headband, now of polyethylene tenite, retains its strength and flexibility under extremely high and low temperatures, is low in moisture absorption and highly acid resistant.

New sweatband, now of soft lined leatherette, goes clear around the head.

For complete details write to Jackson Products, Inc., Warren, Mich.

Automatic Welding Equipment

A new line of "Sureweld" semiautomatic and fully automatic welding equipment, said to provide maximum versatility and economy in CO_2 and inert-gas metal-arc welding, has just been announced by National Cylinder Gas Co., Chicago, Ill.



The new equipment is designed for single pass horizontal and flat position welding, using a constant voltage-type d-c power source. It consists of a welding control and electrode drive unit, a welding gun or automatic welding torch, and interconnecting gas and water cable assemblies.

The function of this equipment in a consumable electrode welding system is to feed electrode into the arc at a constant, preselected speed. It provides a means for starting and stopping the arc, adjusting the electrode feed speed, "inching" the electrode, controlling the arc welder power, and controlling the flow of shielding gas—automatically and in proper sequence.

There are four "Sureweld" SA welding outfits available. Complete information on the new equipment is available from National Cylinder Gas Co., 840 North Michigan Ave., Chicago 11, Ill.

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Company Processing Sugar Beets

They Switched to Nickel-Silver for Retreading with Wear-Resisting Build-Up Metal!

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WALL CHART TO HELP YOU SELECT BEST FOR JOB FROM 86 ALL-STATE PRODUCTS

Put one up in your supply room . . . another on your shop wall . . . to help guide selection of the right Alloy and Flux for the job at hand.

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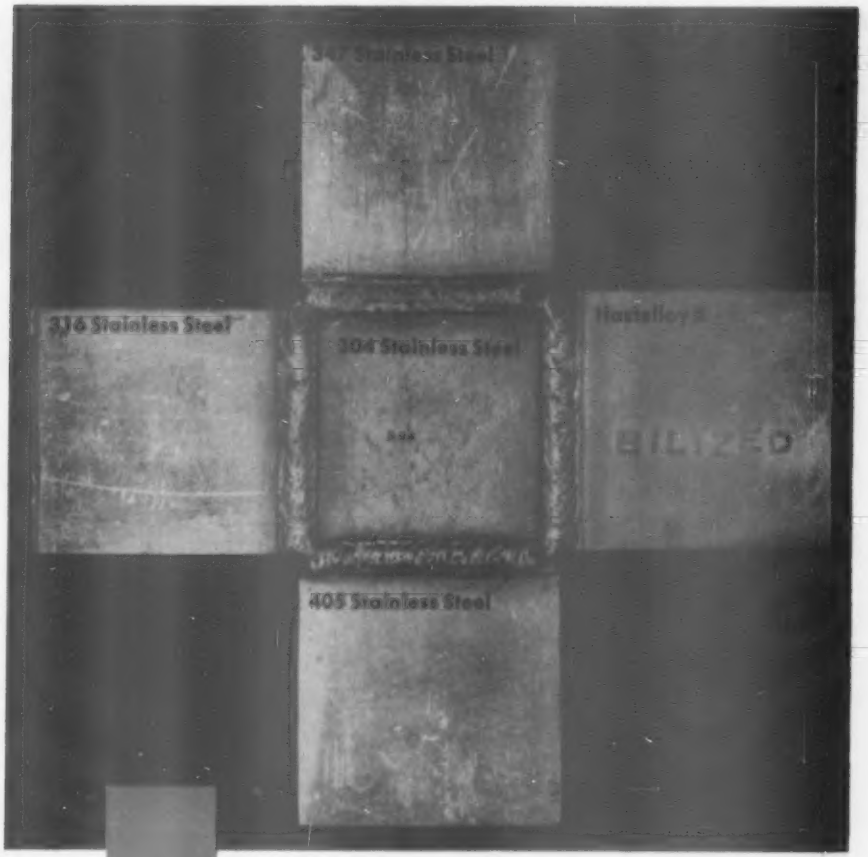
ALL-STATE WELDING ALLOYS CO., INC., WHITE PLAINS, N. Y.



Versatile Inco-Rod "A" produces strong, sound, ductile welds in a wide variety of dissimilar alloys. In *this* test specimen it joined four different alloys to the Type 304 Stainless Steel plate at center.

Versatility is the big plus you get only with Inco-Rod "A"

This 4-to-1 test specimen demonstrates the *variety* of dissimilar alloys you can weld with new Inco-Rod "A"* electrode.

In this specimen, Type 304 Stainless Steel is joined to Types 405, 316, and 347 . . . and to Hastelloy B. There's *proof* of versatility . . . the big plus that Inco-Rod "A" electrode alone can give you.

Industry is proving that Inco-Rod "A" welds *most* dissimilar alloy combinations . . . ferritic and austenitic stainless steels, low alloy steels, mild steels, high nickel alloys, and other alloys.

With each combination, the weld is strong and ductile . . . of X-ray quality. Impact properties at sub-zero temperatures and stress-rupture properties at elevated temperatures are of high order. Corrosion resistance, too.

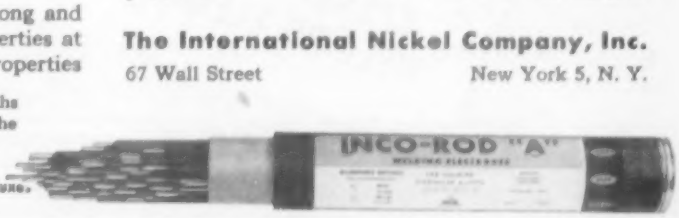
What's more, Inco-Rod "A" . . . the electrode with the distinctive green flux coating . . . is *easy*-handling. Gives excellent operability in any position . . . spray type arc . . . good slag removal.

Write Inco's Mechanical Engineering Section and ask about the alloys *you* want to weld. Chances are good they can help you. New, unpublished data on Inco-Rod "A" electrode constantly coming in from the field, may provide a ready answer to your problem.

*Trademark of . . . International Nickel Company, Inc.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

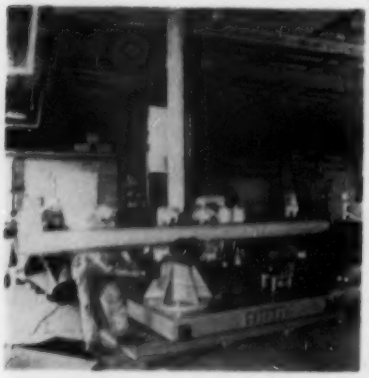
INCO-ROD "A" electrode is supplied in 14-inch lengths in four diameters, 3/32-, 1/8-, 5/32-, and 3/16-inch (the 3/32-inch is center grip) . . . packed in 5-lb. containers.



INCO **Welding Products** • electrodes, wires, fluxes

Ram-Type Manipulator

C. B. Herrick Manufacturing Corp. announces that it has made several important modifications in its line of automatic ram-type welding head manipulators.



Both ram travel and travel of entire unit on track is controlled by electronic variable speed drive unit providing speed range of 5 to 100 ipm. (or any desired 20:1 ratio). Dynamic braking stops ram instantly. Motorized double chain lift, plus counterweight in column and brake motor accomplish vertical movement of ram.

Vee wheels guide lateral and vertical travel on SAE 4150 vee ways. Manual rotation of 360 degrees is within heavy cast base. Positive lock holds column and ram firmly in working position.

For complete details write to C. B. Herrick Manufacturing Corp., 2000 Center St., Cleveland, Ohio.

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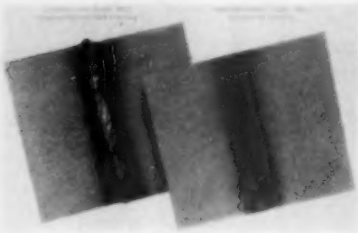
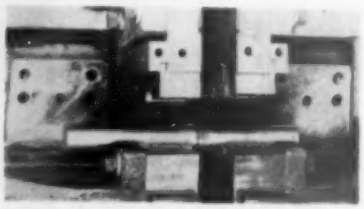
Flash Welder

A new flash welder for steel products that trims the flash extrusion as it makes the weld has been introduced by Thomson Electric Welder Co. of Lynn, Mass.



According to manufacturer, the new flash welder, called "Synchro-Shear," is a further development of the Thomson "Synchro-Matic" flash welder, a precision controlled, automatic resistance welder which freed the process from the limitations of operator skill and stamina.



"Synchro-Shear" is designed to handle carbon steel from mild to 1.00 carbon, high speed steel, high alloy steel and stainless steel. It will weld and trim all shapes normally encountered in flash welding including flats, squares, rectangles, rounds and most irregular or extruded shapes.

"Synchro-Shear" flash welders are available in a complete range of standard RWMA sizes. Complete information is available from Thomson Electric Welder Co., Lynn, Mass.

WATER MIZER
Model ET101
Patented TM Reg.
Water is Scarce Why Waste It?
WATER MIZER saves water—and money, too. Here is a typical example how WATER MIZER controls cooling water on resistance welders and saves up to 80% on consumption. Data below is from an actual production job test in a well-known factory.
BEFORE INSTALLATION
8 hour work day
8 hours of water flow
2960 gallons used
AFTER INSTALLATION
8 hour work day
1½ hours of water flow
495 gallons used
WATER MIZER pays its way in a short time. Satisfied users report very little servicing necessary. Ask for data on units for resistance welders, for induction heating, for hydraulic systems.
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Hard-Facing Gives This Valve Part A Longer Life In High-Temperature, High-Pressure Service.

Mechanization Speeds Production . . .

Cuts Cost of Hard-Facing by 40%

Valve parts hard-faced with HAYNES STELLITE alloy No. 6 have unusual resistance to oxidation, erosion, seizing and galling, corrosion, and abrasion. They will withstand wear even at elevated temperatures, and operate for long periods of time in high-temperature, high-pressure service.

Reclaiming worn valve parts or protecting new ones by hard-facing has always been an economical practice. Now mechanization has made it even more attractive. Mechanized hard-facing is fast . . . up to four times faster than manual methods. It produces smooth, sound deposits that require less finishing time. And because it provides closer control over the hard-facing operation, less rod and less oxygen and acetylene are consumed.

Haynes Stellite Company designs and produces mechanized equipment for depositing hard-facing rods by the oxy-acetylene process. Machines are available for surfacing flat, longitudinal surfaces; flat, angled or grooved parts; and for handling cylindrically shaped parts. Write to any district office for more information on mechanized equipment and on the 19 HAYNES hard-facing alloys.

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125	388	1050
138	400	1100
150	413	1150
163	425	1200
175	438	1250
188	450	1300
200	463	1350
213	475	1400
225	488	1450
238	500	1500
250	550	1550
263	600	1600
275	650	1650
288	700	1700
300	750	1750
313	800	1800
325	850	1850
338	900	1900
350	950	1950
363		2000

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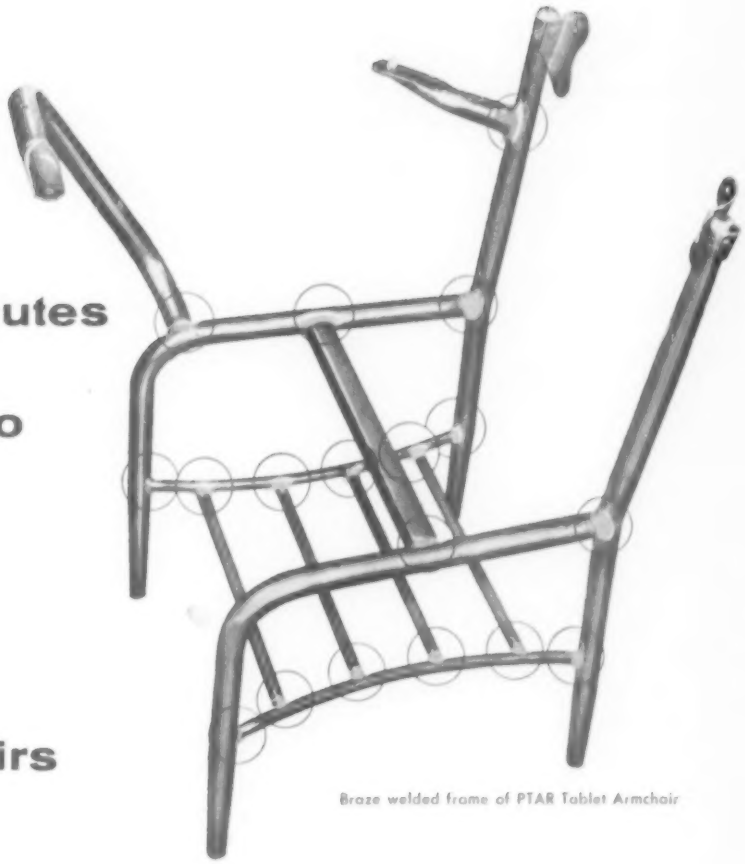
18 Smooth, Uniform Braze Welds in 8 minutes Add Economy to Quality in Peabody Classroom Chairs



Braze welded frame of PTAR Tablet Armchair

Braze welded frames for Peabody school furniture—combination of chair and open-front table.

Anaconda-997 Low-Fuming Bronze Rods Make Well-Shaped Braze Welds, Essential for Eye Appeal and Extra Strength, Says Leading School Furniture Manufacturer—and Lower Production Costs too.

The Peabody Seating Company, Inc., North Manchester, Ind., has been making quality school furniture since 1902. Well-shaped braze welds, they say, are essential to maintain this quality. And they have found that Anaconda-997 Low-Fuming Bronze Rods make this kind of joint, not only adding eye appeal but providing the extra strength needed in school furniture.

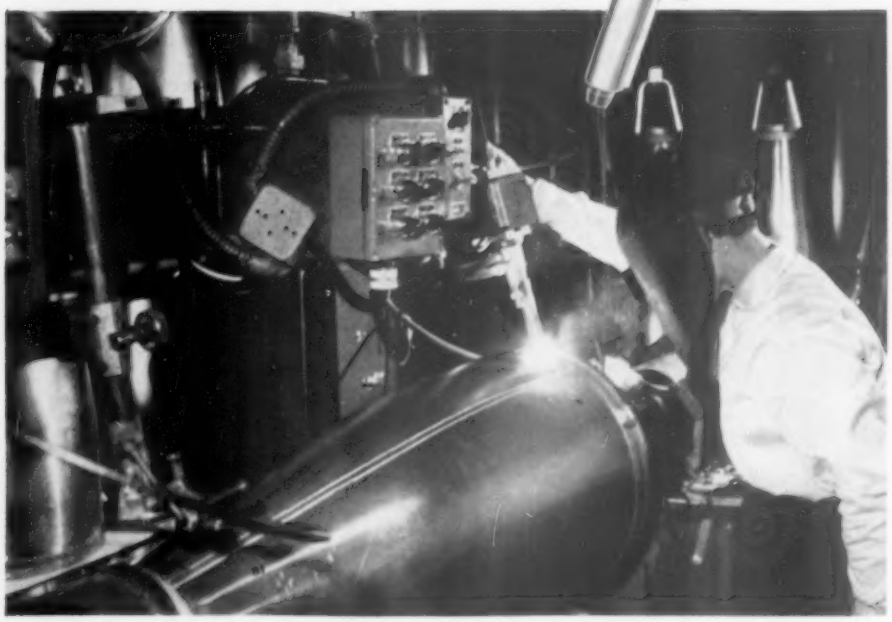
By depositing smooth-flowing and low-fuming weld metal, these rods promote faster, more uniform work and thereby reduce production costs. The 18 braze welds pictured are made in 8 minutes—an average of about ½ minute per joint.

Anaconda-997 Low-Fuming Bronze is a superior welding rod used to join gray and malleable cast iron, steel and copper alloys by the oxyacetylene process. It is also used for repair welding, and to deposit bearing surfaces on steel and iron. You can get other Anaconda Copper Alloy Welding Rods for many different production and repair purposes. They are sold by distributors of welding equipment everywhere. Anaconda distributors are also a good source of practical advice on welding problems. Purity Cylinder Gases, Grand Rapids, Mich., and Warsaw, Ind., furnish Peabody with Anaconda-997 Rods. For additional information write for Publication B-13. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

WELDING RODS

New AIRCOMATIC® HEAD for better machine welding



New AMH-B Head welding cylindrical containers on a high production basis. All components of this Aircomatic package — power supply, inert gases, and Aircomatic welding wire — are available from Airco.

The new improved Airco AMH-B Aircomatic Head has been developed for the fabrication of ferrous and nonferrous metals on a high production basis. Used in conjunction with constant arc voltage power supply, this unit provides automatic control of the arc voltage. Standard shielding gases—argon, helium, mixtures (AG75) and CO_2 —are used. Advantages of the AMH-B include: two speed ranges, up to 900 inches per minute high range, and up to 600 inches per minute low range; all types of Aircomatic welding wire, from .030" to 3/32" diameters, can be used.

Wire is fed at a constant speed by an adjustable speed motor. Easy adjustment of the head allows it to be used vertically or horizontally.

For handling most applications the basic package consists of the Aircomatic unit, a machine barrel and a wire guide component kit. The basic Aircomatic unit includes the head, main control panel and remote control operator's station. For complete information write Airco direct.

welding
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